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VOL. CXLIV.—No. 3744] LONDON: FRIDAY EVENING, OCTOBER 14, 1927 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Assistant Engineer for the PUBLIC WORKS DEPARTMENT DRAWING-OFFICE REQUIRED by the GOVERNMENT of BRITISH GUIANA, for two years' service, with possible permanency. Salary £350, rising to £400 a year by annual increments of £25. Free passages. Candidates, unmarried, about 23 years of age, should have passed Sections A and B of the A.M.I.C.E. Examination, or hold equivalent professional qualifications, and be neat and expeditious Draughtsman.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15,362. 6768

Assistant Engineers REQUIRED for the PUBLIC WORKS DEPARTMENT of the FEDERATED MALAY STATES for four years' service, after which, subject to satisfactory service, the officers appointed will be eligible for confirmation in the permanent and pensionable establishment. It is probable that the number of permanent appointments will be sufficient for those officers whose services have been entirely satisfactory, but no guarantee can be given. If at the end of four years' service an officer's services have been entirely satisfactory, and he is not offered or declines further employment, he will be paid a bonus of 2850 dollars. Salary 400 dollars a month, rising to 800 dollars by annual increments of 25 dollars, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax at present imposed by the Federated Malay States Government. Free passages provided. Candidates, age 22 to 26, preferably unmarried, must have received a good theoretical training, preferably at a University or College recognised by the Institution of Civil Engineers, and possess a Civil Engineering Degree or obtained such other Diploma or Distinction in Engineering as the Secretary of State may decide in any particular case or have completed articles with a Civil Engineer of good standing, and have passed the Examination for Associate Membership of the Institution of Civil Engineers. In addition, candidates must have had at least one year's practical experience of Civil Engineering under a qualified civil engineer.—Apply at once by letter, giving brief details of qualifications and experience, and stating age, and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting clearly at the head of application M/15,224. 6769

Naval Architect REQUIRED by the GOVERNMENT of NIGERIA for the MARINE DEPARTMENT, for two tours of from 12 to 18 months, with possible permanency. Salary £960 a year, plus a duty allowance of £96 a year. Free quarters and passages and liberal leave on full salary. Candidates, age 28 to 35, should be members of the Institution of Naval Architects, and have had practical Designing Experience of all types of River and Harbour Craft, especially of Light Craft and Construction.—Apply at once by letter, stating age and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M 3. 6770

The High Commissioner for India is prepared to receive APPLICATIONS for the undermentioned APPOINTMENT in the service of the Government of the Punjab :—
ENGINEER for SANITARY DEPARTMENT, Buildings and Roads Branch.

Candidates should have had a sound general education, possess a recognised degree in engineering or equivalent qualifications, and have had at least two years' practical experience of sanitary engineering, design or construction. Age 26 to 30 years.

Information regarding the conditions of appointment and form of application may be obtained, upon request by postcard, from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 10th November, 1927. 6714

Borough of Weymouth and Melcombe Regis.

TOWN BRIDGE RECONSTRUCTION, GENERAL CONTRACT.

TENDERS are INVITED for the GENERAL WORK to RECEIVE and SUPPORT a TWO-LEAF BASCULE BRIDGE, including Foundations in the harbour supporting Stone-faced Reinforced Concrete Walls, Parapets, Control House, &c., Temporary Footbridge, Roadway Widenings on Reinforced Concrete Piles and Platform. The steel bridge is being tendered for separately and is to be embodied in this general contract as a sub-contract.

Drawings are prepared and can be seen at the office of the Engineer for the work, Mr. H. W. Fitzsimons, B.Sc., M. Inst. C.E., 30, Victoria-street, Westminster, S.W. 1. Copies of the specification, bill of quantities, and form of Tender are to be obtained from the Engineer's office on payment of Three Guineas, which sum will be returned upon receipt of a bona fide Tender and the return of all documents.

Tenders are to be sent to the undersigned not later than Noon on Monday, the 31st October, and endorsed "W.T.B.G.C."

The Corporation does not undertake to accept either the lowest or any Tender.

F. SMALLMAN,
Town Clerk.

Town Clerk's Office,
Wermouth. 6749

City of Hull Waterworks.

COTTINGHAM PUMPING STATION.
CONTRACT No. C 2.

The Water and Gas Committee are prepared to receive TENDERS from British Manufacturers for the CONSTRUCTION and ERECTION of THREE SETS of PUMPING PLANT (each set capable of delivering 4 million gallons of water per 24 hours), FOUR LANCASHIRE BOILERS, ECONOMISER and WATER SOFTENER at their Cottingham Pumping Station. Copies of the specification and forms of Tender, together with drawings of the existing buildings, can be obtained on or after Friday, the 21st instant, from the undersigned on payment of a deposit of £5, which will be refunded on receipt of a bona fide Tender. Cheques to be made payable to Mr. F. Steadman, City Treasurer.

Sealed Tenders, endorsed "Pumping Plant, Cottingham," must be delivered at the Town Clerk's Office, not later than 10 a.m. Monday, the 7th November, 1927.

W. D. BINGHAM,
Water Engineer.

Guildhall, Hull,
12th October, 1927. 6767

The Engineer

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PUBLIC NOTICES

Bombay, Baroda and Central India Railway Company.

The Directors are prepared to receive up to Noon on Friday, 28th October, TENDERS for the SUPPLY of—

1. WHITE LEAD.
2. PAINTS, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1.
12th October, 1927. 6745

Metropolitan Water Board.

COVERED SERVICE RESERVOIR AT BISHOPS WOOD, HORNSEY.

The Metropolitan Water Board invite TENDERS for the CONSTRUCTION of a COVERED SERVICE RESERVOIR in Mass and Reinforced Concrete, having a capacity of 20¼ million gallons, at Bishops Wood, in the Borough of Hornsey, in the County of Middlesex.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities may be obtained on and after Monday, 24th October, 1927, from the Chief Engineer, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Bishops Wood Reservoir," must be delivered at the offices of the Board (Room 122) not later than 10 a.m. on Monday, 21st November, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Roseberry-avenue, E.C. 1
6th October, 1927. 6712

PUBLIC NOTICES

Metropolitan Water Board.

MAIN—FORTIS GREEN TO SOUTHGATE.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of approximately 5960 LINEAL YARDS of 24in. Diameter CAST IRON MAIN, together with CONNECTIONS and CONTINGENT WORKS, from Woodside-avenue, Fortis Green, in the Borough of Hornsey, to Durnsford-road, in the Urban District of Wood Green, and from Chase-road to the Board's Reservoir at Southgate, in the Urban District of Southgate, within the County of Middlesex.

The drawings and contract documents may be inspected without charge at the Offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specifications and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after Monday, 24th October, 1927, from the Chief Engineer, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Main, Fortis Green to Southgate," must be delivered at the offices of the Board (Room 122) not later than 10 a.m. on Monday, 21st November, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Roseberry-avenue, E.C. 1,
6th October, 1927. 6713

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

DEVELOPMENT DRAUGHTSMAN.—SITUATION advertised by Glenfield and Kennedy, Ltd., Kilmarnock, on August 26th, HAS NOW BEEN FILLED. Owing to the large number of applications received, it has not been possible to make individual acknowledgment, and the company therefore take this opportunity of tendering their thanks to the respective applicants. 6772

PUBLIC NOTICES

Scarborough Corporation.

NEW IRTON WATER SCHEME.
CONTRACT No. 4.
PUMPING STATION BUILDINGS.

The Corporation invite TENDERS for the CONSTRUCTION of a high-class PUMPING STATION BUILDING on the property of the Corporation Waterworks at Irton, near Scarborough.

The Contract will include Foundations of Reinforced Concrete Piles and Beams and a Superstructure of Brickwork with Artificial Stone Dressings; Reinforced Concrete Roof, &c. Foundations for machinery, embanking, road-making and short lengths of pipe-laying are also included in this contract.

Copies of the conditions, specification, schedule of prices and form of Tender, prepared by the Engineer, Dr. Herbert Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, may be obtained on application to the UNDERSIGNED on or after Monday, October 17th. The application must be accompanied by a sum of £5, which will be refunded on return of the documents within seven days or after the receipt of a bona fide Tender and the documents required.

Facilities for examining the drawings, for inspecting the site and general information can be obtained on application to Mr. Herbert Richardson, M. Inst. W.E., the Water and Streets Engineer to the Corporation, Town Hall, Scarborough, and from Mr. M. B. Mawson, M. Inst. C.E., the Resident Engineer for the New Irton Scheme, Spring Hill, Scarborough.

Tenders are to be sent in on the form supplied, and with the annexed documents must be enclosed in a sealed cover, endorsed "New Irton Water Scheme; Tender for Contract No. 4," addressed to and reaching the UNDERSIGNED not later than 10 a.m. on Monday, November 7th.

It is particularly requested that none but Engineering Contractors experienced in heavy foundation and reinforced concrete work should apply.

The Corporation do not bind themselves to accept the lowest or any Tender.

SYDNEY JONES,
Town Clerk.

Town Hall, Scarborough,
11th October, 1927. 6748

State Electricity Commission of Victoria.

22-32, William-street,
MELBOURNE,
AUSTRALIA.

TENDERS are hereby invited for the MANUFACTURE, SUPPLY and DELIVERY for the Yallourn Brown Coal Works, Victoria, Australia, PLANT for the ELECTRICAL PRECIPITATION of BROWN COAL DUST in accordance with specification No. 27/85.

Copies of Tender form, specification, &c., will be available upon application to :—

THE AGENT GENERAL FOR VICTORIA,
Victoria House,
The Strand,
London, ENGLAND,
and
HERR J. KLITZING, BERGWERKSDIREKTOR,
Grube Mates,
Bei Senftenberg,
GERMANY.

CHARGE :—
£1 1s. for three copies of Tender form, conditions of contract and specification complete. This charge will be returned in the event of a bona fide Tender being received. Extra copies 10s. 6d. each, not returnable.

PRELIMINARY DEPOSIT :—
A preliminary deposit of £50 is to be lodged with Tender or at the Office of the Agent General for Victoria.

Tenders on prescribed form, properly endorsed and addressed, must be delivered at the Office of the Commission, Melbourne, not later than 12th December, 1927.

The Commission does not bind itself to accept the lowest or any Tender.

W. J. PRICE,
Acting Secretary.

6697

The Madras and Southern Mahratta Railway Company, Limited,

25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—

(1) SPARE PARTS for CARRIAGES and WAGONS (Horn Cheeks, Axle Guards, &c., Buffer Parts, Buffer Hooks and Details, Draw-bars, Screw Couplings, &c. &c.).
(2) 15,300 PAIRS FISH-PLATES for B.S. 90 B.H. RAILS.
(3) 87,500 FISH BOLTS for 90 lb. B.H. and F.P. RAILS.
(4) 26,320 BEARING PLATES for 90 lb. F.F. RAILS.

Tenders are due in as follows :—
No. (1) by 2 p.m. on Tuesday, 1st November, 1927.
Nos. (2) to (4) by 2 p.m. on Tuesday, 25th October, 1927.

Tender forms obtainable at above address; fee One Guinea each, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 6716

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PUBLIC NOTICES

Abertillery and District Water BOARD.

SALE OF PLANT.

The above Board offer FOR SALE extensive ELECTRICAL, STEAM, and other PLANT, recently used in the construction of a large concrete masonry dam.

The following are some of the principal items :—

Generating Plant, consisting of No. 2 Ruston and Hornsby 230 H.P. Gas Engines and Producer Plants with No. 2 Metropolitan-Vickers 150 kW, 500-v. Dynamos.

No. 1 160 H.P. National Gas Engine and Producer Plant with No. 1 Bruce-Peebles 100 kW, 500-v. Dynamo.

No. 4 Anderson-Grice 2-ton 3-motor Electric Loco. Cranes.

No. 4 Steam Derrick Cranes, 4 and 5-ton.

No. 2, 14in. by 12in. Ingersoll-Rand Air Compressors with 500-volt Motors.

No. 1 W. D. Wild Haulage Engine and Motor.

No. 1 Double Concrete Hoist, 180ft. high, by Stothert and Pitt, with trussed steel chutes, hoisting winches, ¼-yard mixers, and 500-volt motors.

No. 1 Crushing and Sand Plant, by Hadfields, comprising No. 2 Jaw Breakers, 20in. by 10in.; 2 Hecla Disc Crushers; 1 Jaw Breaker, 16in. by 9½in.; 1 Pan Mill, Screens, Elevators and Shafting, driven by No. 3 75 H.P., 500-volt Motors.

No. 1 Leyner Drill Sharpener, by Ingersoll-Rand Co.

No. 1 Oil Furnace and Tank.

No. 7 Steam Locomotives, 3ft. gauge.

No. 1 5-ton Cableway, by Henderson, 1100ft. span, luffing head masts, electrically driven.

No. 4 Steam Loco. Cranes, 3 and 5 ton.

Together with many other items.

Further particulars can be obtained from the Board's Engineer, Mr. J. FRANCIS JUPP, M. Inst. C.E., Midland Bank Chambers, Newport, Mon. 6701

City of Bath.

APPLICATIONS are INVITED for the POSITION of ASSISTANT ENGINEER in the Waterworks Department. Salary £400 per annum. No Superannuation scheme is at present in force.

Candidates must be thoroughly competent Surveyors, Levellers and Draughtsmen, and have a wide experience of Water Engineering.

Applications, on forms to be obtained from the undersigned and accompanied by copies of not more than three recent testimonials, to be sent to me not later than Friday, the 28th October, 1927, in an envelope marked "Assistant Waterworks Engineer."

Canvassing, either directly or indirectly, will disqualify.

J. BASIL OGDEN,
Town Clerk.

Guildhall, Bath.
11th October, 1927. 6744

Coimisiun um Stat-Sheirbhis.

POST VACANT.

HYDRO-ELECTRIC DEVELOPMENT ON THE RIVER SHANNON.

APPLICATIONS are INVITED from experienced Engineers for TWO POSTS as TRANSFORMER STATION ENGINEERS, to be filled not later than 1st January, 1928, on the Electrical and Mechanical Staff of the above-named constructional works. Salary £400 per annum, with possible increases to £500 per annum, inclusive.

The appointments, which will be temporary and non-pensionable, will be made by the Minister for Industry and Commerce on the recommendation of the Civil Service Commissioners, who will investigate the qualifications of candidates with the assistance of a Board of Selection appointed by the Commissioners.

The latest date for receiving applications, which must be on the prescribed form, is 25th October, 1927. Copies of the form and further particulars may be obtained from the SECRETARY, Civil Service Commission, 33, St. Stephen's-green, Dublin.

17/8. 1684 6755 W. H. Co.

SITUATIONS OPEN (continued)

WANTED, a MAN to Supervise the Work of Relaying the Mumbles Railway; experience in Railway Track Work essential. Period of engagement about six months. Application forms to be obtained from the—

SECRETARY,
MUMBLES RAILWAY,
British Electrical Federation Offices,
88, Kingsway,
6763 A London, W.C. 2.

WANTED, ENGINEER with Experience in the Design and Manufacture of Artificial Silk-making Machinery, to act as ASSISTANT to Manager. Trade connections essential, as successful applicant would require to call on buyers and obtain orders. —State age, experience and salary required, and address application to P3765, The Engineer Office. P3765 A

ADVERTISEMENT REPRESENTATIVE. — A VACANCY EXISTS on the STAFF of "THE ENGINEER" for an ADVERTISEMENT REPRESENTATIVE in the London area.—Applications, giving full particulars of age, experience, qualifications, &c., which must be made by letter only, should be marked "Private," and sent to the MANAGER of "The Engineer," 33, Norfolk-street, Strand, London, W.C. 2.

A LARGE PROGRESSIVE FIRM, Engaged in the Light Engineering Trade in the Midlands, REQUIRES the SERVICES of a highly trained ENGINEER with experience in Machinery, Tools, &c., and with some knowledge of Foundry Management. Applicants should be capable of supervising a large organisation and accelerating production. Age about 25 years. Salary according to qualifications.—Apply, with full particulars and copies of references, to Box 902, Mundy, Gilbert and Troman, Advertising Offices, Birmingham. P3731 A

ACTIVE DIRECTORSHIP OFFERED in Midlands district to man of good type with Works Connections. Experiences Gauging and Production Methods essential.—Write, Box 417, Sells, Fleet-street, E.C. 4. 6737 A

AN INSPECTOR is REQUIRED Shortly to Supervise the Laying of 4 miles of Water Mains, Erection of a Pumping Station Building, Oil Engines and Pumping Machinery in the Midlands. Period about 9 months. Pay, £6 6s. per week. Only those experienced in pipe-laying, building and machinery erection should apply, giving age and experience, and enclosing copies of recent testimonials.—Address, 6757, The Engineer Office. 6757 A

ASSISTANT ENGINEER (Age 25 to 35) WANTED for Contractors' Business in the Home Counties; Main-laying Experience essential. Send full particulars of qualifications, experience and salary required.—Address, 6761, The Engineer Office. 6761 A

CHIEF ENGINEER, MECHANICAL and ELECTRICAL, REQUIRED, having specialised knowledge of Extra High-tension Sub-station Equipment and Design.

Applications, stating age, nationality, salary required, full particulars of experience (mechanical and electrical), and where obtained, should be marked "Application, Private," and addressed to the MANAGER, The British Electric Transformer Co., Ltd., Hayes, Middlesex, England. 6583 A

ENGINEER REQUIRED, with Experience in Quarrying and Crushing Plant, to Take Mechanical Charge of Works in Yorkshire. Good house available. State experience, age, married or single, and salary required.—Address, 6747, The Engineer Office. 6747 A

MANY SKILLED ENGINEERS, Owing to Depression in the industry, fail to see any immediate prospects of advancement. A good Engineering Training is the basis for good salesmen for lubricants. Any Engineers wishing to become Salesmen are invited to write to Box 109, c.o. Walter Hill, 67/9, Southampton-row, London, W.C. 1, giving all particulars and qualifications, age, &c. THESE WILL BE CONSIDERED FOR APPOINTMENTS WHICH WE HAVE IN VIEW. 6752 A

SITUATIONS OPEN (continued)

EXPERIMENTAL TESTER.—ENGINEER, Experienced Four-cycle Heavy-oil Engines, to Take Charge of and develop Department of Manufacturing Company. Good mathematician, with drawing-office experience, desired. Age 30-35. Commencing salary about £450, or according capabilities.—CALL, C. W. PETTY AND COMPANY (APPOINTMENT SPECIALISTS), 58, HAYMARKET, S.W. 1. 'PHONE, GERRARD 3412-3. P3760 A

REQUIRED, CHARGE ENGINEER for Private Power House. Applicants should state experience with Modern Boilers, Steam Plant, Turbines, Electrical Plant. Salary approximately £450.—Address, P3759, The Engineer Office. P3759 A

SUPERINTENDENT ENGINEER WANTED by a Large Concern to Reorganise Production in their various works on progressive economical lines; only an engineer of experience capable of producing evidence of success in a similar capacity will be considered.—Address, giving fullest details of past record in strict confidence, 6698, The Engineer Office. 6698 A

WANTED, a Competent DRAUGHTSMAN for Detailing Grain Elevating and Conveying Machinery. Applicants to state experience, age, and salary required.—Address, 6724, The Engineer Office. 6724 A

WANTED, by Manchester Engineering Firm, DRAUGHTSMAN, with experience in Centrifugal Pump and Heat Transfer work; also Two JUNIOR DRAUGHTSMEN, with previous Drawing Office experience. State age, experience and salary. —Address, 6766, The Engineer Office. 6766 A

WANTED, First-class MECHANICAL DRAUGHTSMAN for large Municipal Electricity Supply Undertaking in the North; must be experienced in Boiler House and Power Station lay-outs.—Address, stating age, experience and salary required, 6771, The Engineer Office. 6771 A

WANTED, First-class DRAUGHTSMAN, with Good experience in Coal Elevating and Conveying Plants and Structural Steel Work.—Address, 6721, The Engineer Office. 6721 A

WANTED in London, Smart CONSTRUCTIONAL DRAUGHTSMAN, one able to Design. State age, experience and salary required.—Address, 6740, The Engineer Office. 6740 A

DRAUGHTSMAN (First-class) REQUIRED, with good experience of Metalliferous Mining Plant and Machinery.—Apply, stating age, experience and salary required, to FRASER and CHALMERS, ENGINEERING WORKS, Erith, Kent. 6736 A

SITUATIONS OPEN (continued)

LADY TRACER (Temporary) REQUIRED for Oil Refinery in South of England.—Write, stating age, experience and salary required, to Z.J. 948, care Deacon's Advertising Offices, Fenchurch-avenue, E.C. 3. 6733 A

REQUIRED IMMEDIATELY, First-class DRAUGHTSMAN, with Heating Experience, particularly for all Drying Purposes. Permanency and splendid prospects with progressive firm in the Midlands for the right man. Outside experience an advantage. Give full particulars of experience, age, salary required, and when at liberty.—Address, 6759, The Engineer Office. 6759 A

YOUNG DRAUGHTSMAN (Age 22-25) REQUIRED for London Office; experience of Conveying and Elevator Machinery essential.—Address, stating age, experience and salary required, P3755, The Engineer Office. P3755 A

WANTED for India, a First-class FOREMAN MOULDER for Steel Foundry, making a large variety of Steel Castings, chiefly for Railway Rolling Stock. Applicants must have had experience in mass production from pneumatic and hand moulding machines and be able to design their own plate patterns, &c., from engineers' drawings. A knowledge of sands and the manufacture of moulders' composition, core sands, &c., is essential. Good organiser and one tactful in handling labour. Salary Rs. 600 per month, with house allowance of Rs. 100 per month. Three years' agreement with second-class passage out and home. Single man preferred.—Apply, giving full particulars of past experience and present employment, to No. 941, Advertiser Office, Dundee. 6720 A

FOREMAN ENGINEER REQUIRED to Supervise Erection of large Well Pumps and Engines in England. Only men with previous experience of this class of work need apply. Give full particulars of plants erected, age, salary required, &c.—Address, 6461, The Engineer Office. 6461 A

FOREMAN, with Knowledge of Sheet Metal, Acetylene Welding and Small Boiler Work, WANTED for SOUTH LONDON.

Applicant must be able to design and make own press tools and organise works for quick production.

Send particulars of experience, age, wage required, and recent reference, to P3766, The Engineer Office. P3766 A

TWO FITTERS REQUIRED for Erection on Site of Heavy Pumping Machinery and Engines. Give full particulars, including age, wage and class of plants previously engaged upon.—Address, 6462, The Engineer Office. 6462 A

SITUATIONS WANTED

A BRITISH ENGINEER (Hydro-electric), with exceptional experience and university training, now returned from abroad on completion of important power plant construction, DESIRES FOREIGN APPOINTMENT on Civil or Electrical Branch. Speaks four languages, has own car, and is thoroughly expert and reliable.—Address, P3739, The Engineer Office. P3739 B

A RESIDENT ENGINEER on Heavy Bridge, Dock or Railway Work. Highest references.—Address, 6442, The Engineer Office. 6442 B

COMMERCIAL ENGINEER, Thorough Technical mechanical and electrical knowledge and extensive business experience, sales organisation and control of staff, home and abroad (six years in India), DESIRES APPOINTMENT. Highest references.—Address, P3752, The Engineer Office. P3752 B

ENGINEER, Good Organiser, Having Recently enjoyed unusual opportunities of inspecting the organisation and methods of manufacture of a large number of the biggest continental engineering, iron and steel works, is PREPARED to ASSIST or ADVISE. Difficult and responsible position preferred. —Address, P3744, The Engineer Office. P3744 B

ENGINEER, Mechanical and Electrical, with 20 years' experience in the design, lay-out and running of large works plants, including boilers, engines, and electrical machinery, DESIRES RESPONSIBLE POST in similar capacity. Used to control of men.—Address, P3730, The Engineer Office. P3730 B

ENGINEER STUDENT (Age 23), Just Finished 2 years' course, willing, adaptable, public school-boy, WANTS POST, large works; no salary.—Write Box 157, at Hornestle's, 60, Cheapside, E.C. 2. P3758 B

EXPERIENCED DRAUGHTSMAN, Used to Layout, Designing and Details of Motor Cars and Lorries, DESIRES ENGAGEMENT. Highest references.—Address, P3770, The Engineer Office. P3770 B

MECHANICAL ENGINEER, with Several Years' Maintenance, lay-out and D.O. experience in large iron and steel works, DESIRES PERMANENT POST with responsibility.—Address, P3762, The Engineer Office. P3762 B

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HOLROYD

USE

HOLROYD GEARS

MADE OF

HOLFOS

REG. TRADE MARK

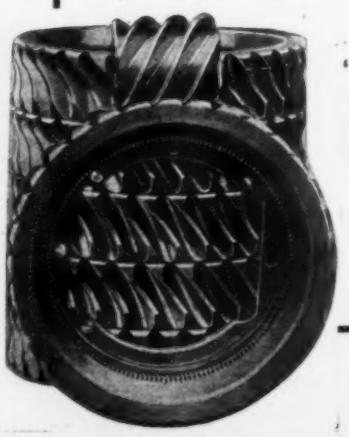
BRONZE

YOUR PROBLEMS ARE OUR OPPORTUNITIES.
LET US HELP YOU TO SOLVE THEM.

JOHN HOLROYD & Co., Ltd.,
MILNROW, LANCS.,

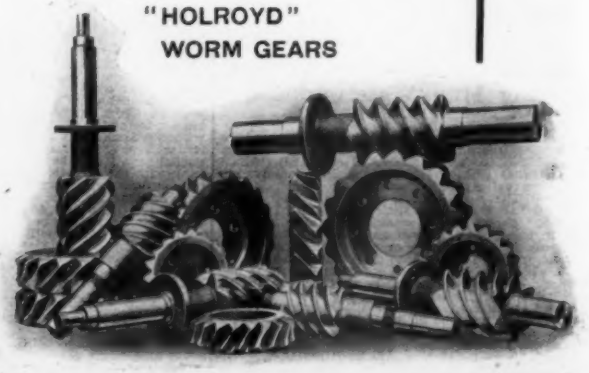
MAKERS OF

MACHINE TOOLS to INCREASE PRODUCTION.



"HOLROYD" BACK AXLE GEARS

"HOLROYD" WORM GEARS



A Seven-Day Journal

The Guggenheim Safe Aircraft Competition.

From the fund of £500,000 left by the late Mr. Daniel Guggenheim for the promotion of aeronautics a prize of £20,000 and five prizes of £2000 each have been set aside for award in connection with a competition for safe aircraft, which is to take place at New York before October 31st, 1929. The competition has excited considerable interest in aeronautical circles all over the world, for it is realised that the conditions laid down are such as to eliminate foolish entries at the outset and to command respect by reason of their scientific soundness and technical importance. Brief particulars of the tests to be fulfilled were given in our issue of June 17th. The conditions are undoubtedly stringent, and it is excusable to believe, as some seem to do, that they are in some respects beyond the reach of technical developments in the time available. It is, however, universally admitted that they are soundly drawn in the interests of promoting safe flying. Since September 1st, when entries for the competition began to be received, several well-known firms have submitted definite applications for permission to compete. So far, we understand, five British firms have entered, namely, the Cierva Autogiro Company, Ltd., the de Havilland Aircraft Company, Ltd., the Gloster Aircraft Company, Ltd., Handley Page, Ltd., and Vickers Ltd. Two American firms, the Schroeder-Wentworth Company, of Chicago, and the Hall Aluminium Aircraft Corporation, of Buffalo, have also entered. Among others an entry is likely to be made by the Fokker Company. Major R. H. Mayo is the British representative of the Daniel Guggenheim fund. The competition is to be carried out at Mitchell Field, Long Island, and the competing machines will be judged from time to time as they come forward.

Railway Electrification.

In dealing with main line railway electrification in a recent address before the Institute of Transport, the President, Mr. Roger T. Smith, drew attention to the results of six years' working of the electrified portions of the Swiss Federal Railways. Those railways, he said, had been able to decrease by 20 per cent. the time of the journeys made by express trains and to improve the slow passenger service. Much heavier goods trains were being hauled than steam locomotives could haul. The average increase in trailing load up to last August was 47 per cent. The capacity of the St. Gothard line for carrying minerals had been doubled. Together with the fall in the cost of coal and wages, electrification had reduced the total cost of traction and of workshops and had enabled 34 per cent. more traffic in ton-miles to be hauled by the whole steam and electric equipment in the last four years, without any appreciable increase in the traffic cost of working the trains and stations. Estimates for main line electrification schemes in this country over long lengths of route showed that the savings in working expenditure as compared with steam would pay on the cost of electrification from 5 per cent. on fairly busy lines to as much as 12 per cent. on lines fully worked with dense mineral and goods traffic throughout the twenty-four hours. The capital cost per route mile of double track had been estimated at £25,000 for suburban lines, and it would probably amount to £60,000 for main lines.

The Future of the Port of Fleetwood.

On Friday of last week, October 7th, the Port of Fleetwood celebrated the fiftieth anniversary of the opening of Wyre Dock. At the jubilee luncheon, which was given at the invitation of Sir Josiah Stamp—the President of the London, Midland and Scottish Railway Company—reference was made to the probable future of the port after the Belfast steamers have been transferred to Heysham. A scheme is now under consideration which aims at giving further berthing and siding accommodation, and an enlarged area for selling, icing, packing and despatching the fish landed at the port. The cost of the scheme, which will be submitted to the Fleetwood trawler owners, is expected, Sir Josiah said, to amount to six figures. The dredged berths of the railway steamers will in due course be available for general cargo vessels, and the railway company intends, it was stated, to foster business developments. The view was expressed that if successful such new business should, together with the increasing trade which will be brought to the town by the various activities connected with the growing fishing industry, ultimately be of greater benefit than the Belfast-Fleetwood services, which, in the main, were concerned with through traffic.

The Export Credits Guarantee Scheme.

Last week Mr. A. M. Samuel explained to representatives of the trade and technical Press the latest developments for insurance against bad debts in the export trade under the Government's export credits guarantee scheme. The scheme was brought into being as a result of the recommendations made by an expert committee of bankers and others appointed about two years ago to examine the whole field of credit insurance. Under the scheme a large number of the Department's contracts are already in operation, but it is believed that the valuable facilities available might be still more widely known. The Government is prepared to guarantee bills of exchange up to 75 per cent. of their face value and in some cases up to 100 per cent. The premium is charged on the amount of the guarantee and is levied at a rate which varies according to the standing of the parties, the importing country, and the length of credit. It is a condition of the guarantee that the goods covered by it must be wholly or partly manufactured in the United Kingdom. Guarantees are not given for shipments to Russia or, so far as textiles are concerned, for shipments to the Far East. The contract form has been produced with the assistance of the Chambers of Commerce, and has since it was drawn up been under close discussion, particularly with the exporters in the Bradford district. If some particular clause of the floating contract is found to be out of harmony with the usual custom or practice of a trade, careful consideration is given to the question of modifying it to suit the conditions.

The Largest Aircraft Carrier.

The United States aircraft carrier Saratoga is about to begin her trials, and will be formally delivered to the Navy Department on October 31st. She has been under construction nearly seven years, the keel having been laid by the New York Shipbuilding Company, at Camden, N.J., on January 23rd, 1921. The Saratoga and her sister ship, Lexington, were begun in the first instance as battle-cruisers, to displace 43,500 tons and to be equipped with turbo-electric drive, the machinery developing 180,000 shaft horse-power for 33·3 knots. The main armament was to have consisted of eight 16in. guns. As a result of the Washington Conference they were subsequently re-designed as aircraft carriers. The displacement was reduced to 33,000 tons, and as the original propelling plant has been retained the actual speed is expected to reach 34·5 knots. The machinery is the most powerful ever installed in a ship, whether naval or mercantile. The Saratoga has 16 White-Forster boilers, burning oil. Protection is afforded to the hull by a belt of armour on the waterline, bomb-proof lower decks, and anti-torpedo bulges. Practically all the auxiliary machinery is operated by electricity. There is hangar accommodation for 72 aircraft, with well-equipped workshops and store rooms. The flight deck is 880ft. long and 90ft. wide. The single gigantic funnel casing, the bridges, mast, and gun turrets are placed well over on the starboard side, leaving the flight deck almost unobstructed. Eight 8in. guns, 55 calibres in length, form the main armament, mounted in twin turrets, two before and two abaft the superstructure. There are also twelve 5in. A.A. guns and four torpedo tubes. In view of the extraordinary power of her engines the steam trials of the Saratoga are awaited with keen interest.

More Orders for Shipbuilders.

Following the news referred to in a Journal note of last week that four 16-knot motor vessels are to be built on the Clyde for the Prince Line, comes the announcement that Bibby Brothers and Co., of Liverpool, have placed an order with the Fairfield Shipbuilding and Engineering Company, Ltd., for a twin-screw motor passenger liner of about 9130 gross tons. The new vessel will be, we learn, generally similar to the Bibby liners Shropshire and Cheshire, which were constructed by the same builders. She will have a length of 502ft., with a moulded breadth of 60ft., and a depth moulded to the upper deck of 32ft. 3in. Her propelling machinery will consist of two sets of eight-cylinder Fairfield-Sulzer oil engines, with a cylinder bore of 28in. and a stroke of 39in. They will have a total output of 7700 S.H.P., giving the vessel a sea speed of about 15 knots. On the North-East Coast Smith's Dock Company, Ltd., which a few weeks ago was considering closing its South Bank Shipyard through lack of orders, has now ten ships and ten sets of steam engines to build. The new orders comprise two 9000-ton Ropner cargo ships, two 300ft., 4600-ton colliers, and six grain carriers for the Great Lakes, which are light draught craft with a length of 260ft. and a deadweight carrying capacity of about 2500 tons.

Industrial Optimists and Pessimists.

According to Mr. D. A. Bremner, director of the British Engineers' Association, sixty-six representative firms in the iron and steel, shipbuilding and engineering industries paid dividends during the past three years which averaged 4·6 per cent. in 1924, 4·3 per cent. in 1925, and 3·9 per cent. in 1926. To pay the 1926 dividend the amount distributed had to exceed the earned profits by 42·2 per cent. Mr. Bremner proceeded, in the course of an interview, to emphasise the basic character of the engineering industry, and stated that its general decay would be inevitable if the adverse conditions with which it was now struggling were perpetuated. It was quite incapable, he remarked, of sustaining its existing financial burdens without progressive loss of vitality. Mr. Bremner's views are in striking contrast to those expressed during the week by such industrial leaders as Lord Gainford, Sir Alfred Mond, and Mr. F. C. Fairholme. Lord Gainford, speaking at Sheffield as President of the Federation of British Industries, said that in his belief the period of stagnation of our foreign trade was past the worst, and that he confidently anticipated a steady upward movement. While our export trade had been suffering from stagnation we had not been standing still as an industrial nation. The unemployment figures were not nearly so disquieting as the totals seemed to imply. When analysed they would be found to reveal the fact that compared with 1913 the increased number of unemployed was just about equal to the increase in the unemployable population. Mr. Fairholme, managing director of Thomas Firth and Sons, speaking on the same occasion, dissociated himself from the pessimistic belief that as a manufacturing nation our prosperity was on the wane. We could, he claimed, still retain the proud position of the world's leading manufacturing country if the opportunities and resources of the Empire were fully exploited. Sir Alfred Mond, speaking in London, also dwelt optimistically on our industrial outlook. As a country of high quality produce we were, he said, bound to suffer more in bad times than countries producing cheap goods. There was every reason to assume that with increased stabilisation, the world's industry would develop, and that our country would have its share of the advantages attending a general increase in the consumption of the world.

Coal Mining Profits.

On Tuesday the Mines Department issued a statistical summary of the position of the British coal-mining industry during the first three months of this year. The figures refute the idea that the industry, as a whole, is not earning a profit. The repeated publication of "ascertainment" figures showing that the yield has not been sufficient to pay the agreed minimum standard percentage and accompanied by a statement that the deficit will have to be made good out of the standard percentage set aside to supply the coal-owners' profits, encourages the belief that the industry is being run at a loss. That, as has been pointed out by others, is not a true interpretation of the figures. In the March quarter all the mines except those in the South Wales and Monmouth district earned a profit ranging from 2·58d. per ton in Scotland to 5s. 1·48d. per ton in South Derby, Leicester, Cannock Chase and Warwick districts. In South Wales the loss averaged 4·88d. per ton. Over the whole country the average profit represented 1s. 2.41d. per ton. The balance of receipts over expenditure amounted to £3,497,463. Of the expenditure of 16s. 1·92d. per ton wages took 11s. 1·85d., management 2s. 7·41d., and stores, etc., 1s. 10·69d. Royalties represented 6·23d. per ton. For the industry as a whole, the output per man-shift averaged 20·66 cwt. and earnings 10s. 7·12d. Commenting upon the figures, an official of the owners' organisation points out that they should do something to correct the misleading statements being made regarding the failure of the owners' post-strike policy. Compared with the March 1926 quarter—when the subsidy was still being paid—they show that the cost of production per ton has been reduced, and the average earnings per shift increased. The deficit balance of over four million sterling, omitting the subsidy, has been converted into a credit balance of nearly 3½ millions.

Fog and the Railways.

The fogs of the past week or so may have tempted some to inquire to what extent the railways suffer by these visitations. The ordinary traveller, judging unthinkingly from the reduction in the number of trains run and the overcrowded state of the carriages, might be tempted to conclude that fogs are of some financial benefit to the companies. Actually any saving effected by a reduction in the number of passenger trains operated is very small compared with the extra costs and losses entailed by foggy weather conditions. Fog in London and its neighbourhood, it has been officially stated this week, costs the railway companies many thousands of pounds a day, and if it should extend to other important centres the burden thrown on the undertakings becomes very great indeed. Fog suspends all work on the permanent way and thousands of platelayers have to take on duty as lookout men, sometimes at a considerable charge for overtime. The fog signals, or detonators, cost about 2s. 6d. a dozen, and as many millions of them may be used in the course of a foggy winter, they represent quite a considerable item in the bill. The slower running of the trains and the frequent stoppages to which they are subjected must of necessity entail a much larger consumption of fuel. The chief source of loss, however, is caused by the curtailment which is enforced on the goods service equally with the passenger service. After the visitation has passed the expense incurred continues to be added to by the steps which must be taken to restore the services to the normal. There are many other ways in which fog affects the financial aspect of railway operation. It can therefore be said with assurance that foggy weather spells an almost unrelieved loss to the railways.

An American Diary.

No. XII.*

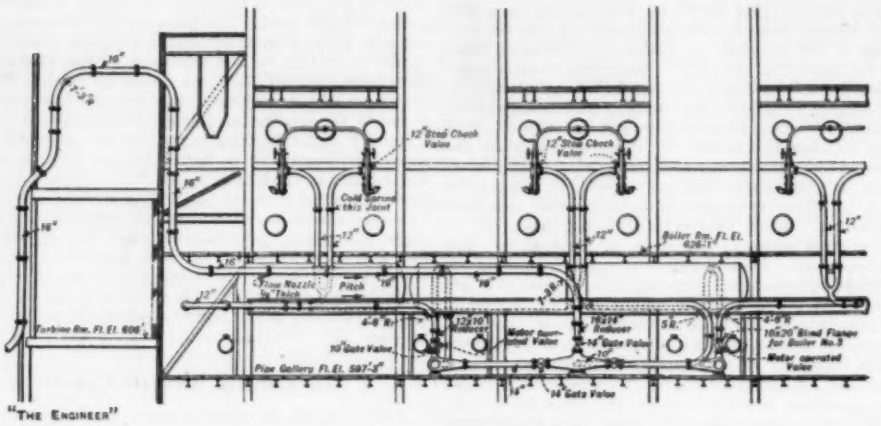
DETROIT.

THE world goes to Detroit to see motor cars made at the rate of one a minute or thereabouts. Motor car building is the staple industry of the city. It turns them out by the gross as Northampton turns out boots. The atmosphere is automobilic. As you talk marrows at a horticultural show, so you talk autos in Detroit. In May the battle between Ford and General Motors was the accepted subject of conversation. In New York you had to be posted in the Snyder case; in Washington the Coolidge problem filled the air; in Chicago you talked "hooch"; but in Detroit your views on the new Ford were canvassed. Henry's own people did not know what it would be like, but they were sure that when it came General Motors would "take a back seat." Rumour had it that Highland Park and Fordson—that colossal factory which was once called River Rouge—would be shut down completely for two days or two weeks—what matters a little "terminological inexactitude?"—whilst the equipment was changed, and then out would come the new design in a cataract that would carry competitors in a clanjamfery before it. Well, it hasn't happened yet, and to this day the motor experts in two hemispheres are airing their "baseless fabrics" and giving tips about the new model straight from the stable, and about as trustworthy, for Mr. Ford, like Brer Rabbit, lies low and says nuffing.

Mixed visions of the mass production of cars, of beautifully kept shops, of a wonderful power house, of glass works and blast-furnaces, and a hundred other things come back to the mind, making of the Ford factories a picture like those strange productions of the post-futurists in which one sees parts of human anatomy involved in geometrical confusion with tables and syphons, fiddles, the grins of niggers, the legs of women, and the sun's rays. But in the centre of the picture "indelibly lined on the tablet of the mind" is the figure of a man with a joiner's brace in his hand. Before him there moves a never-ceasing procession of half-finished Fords, and as each comes in front of him he fits the box spanner bit which is in the brace on to six nuts in turn and tightens them up. He gets six dollars a day for doing that, and he does it all day long, all the week long, all the month long, all the years long, stretching backward for years and forward into years. In prison men complain about the monotony of making scrubbing brushes. It is a varied and delightful occupation compared with this; contrasted with this, it calls for excellent craftsmanship, for gentleness of touch, for intellect even. It is an art by comparison; a man may be an artist in the making of scrubbing brushes. Even "the uncommonest workman," *pace* Joe Gargery, might "show himself uncommon in a gridiron," by comparison with this endless, endless, tightening up of nuts.

TRENTON CHANNEL.

Let us meet Mr. Drysdale and drive away from Detroit and its cars to Trenton Channel power house, in some respects, perhaps, one of the pleasantest of the many great power houses in the Eastern States. It belongs to the Detroit Edison Company, and is the latest of four which supply Detroit and a large area to the north, west and south of the city. The Detroit River is a short and for the most part a wide stream, joining Lake St. Clair to Lake Erie. Detroit itself is practically on the former lake, and the Trenton Channel plant is 12½ miles south of it, situated on an island in the river a few miles from Lake Erie. It is a rather handsome station, as may be judged from a view taken across the water. The turbines are twenty-one-stage impulse machines, and their normal maximum output is 43,000 kW, but they can be overloaded up to 50,000 kW, by opening a valve which admits high-pressure steam to the fifth stage. The steam pressure is 375, and the temperature 700 deg. Fah. Speed 1200 r.p.m. With six turbines of this size the station can develop up to 300,000 kW, but it is possible that larger units may be used in future extensions if the demand is sufficient.

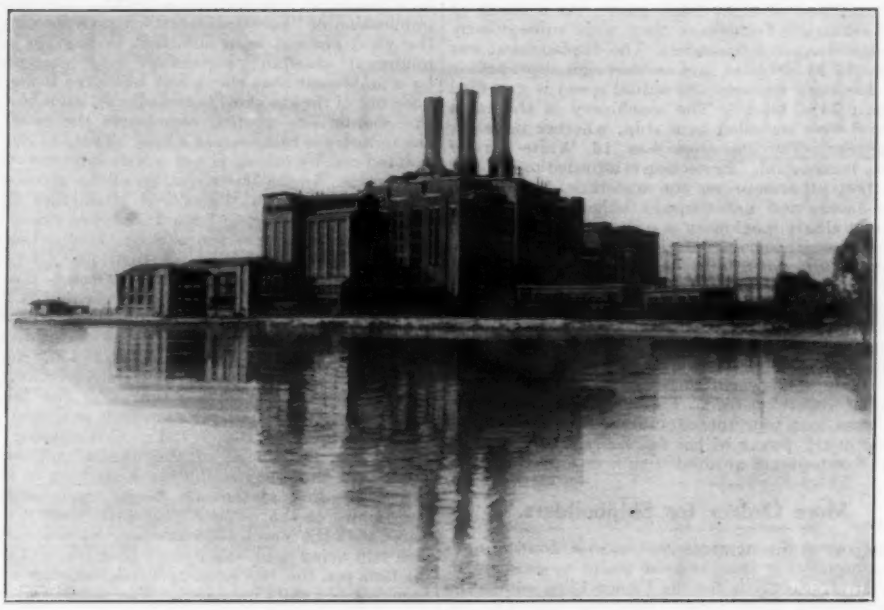


LAY-OUT OF STEAM PIPES AT TRENTON CHANNEL POWER HOUSE

A feature which at once strikes the visitor to the turbine room is the presence of very large openings, or hatches, through the floor, which give light and air to the auxiliaries and condensers below. Openings of some kinds are provided in all turbine-rooms to give access to the lower level, but they are often at one side. At Trenton they are between the turbines and one measures as much as 60ft. by 40ft. One notable advantage of this arrangement is that it makes the lower level readily accessible for crane service.

The main condensers, built by Worthingtons, are horizontal, and, owing to the good quality of the circulating water, have only to be cleaned about once a month. They are of the single pass type, with 50,000 square feet of surface in 1in. tubes. The tube arrangement is unusual, for the fagot of tubes, if we may so call it, is set excentric to the shell, thus leaving a crescent-shaped steam space, the wider part of which is, of course, at the summit. A number of radial lanes amongst the tubes carry the steam freely to the cooling surfaces. About one-quarter of the condenser surface is baffled off from the steam, and serves for air cooling. There are two 48in. circulating pumps to each condenser, and together they will deliver about 100,000 gallons per minute; their motors can develop 325 H.P. each.

The steam pipe arrangements in these big power houses is always interesting; provision must be made for many combinations and the stresses resulting from weight and expansion must be very carefully studied. It would be a profitable task, but a lengthy one, to contrast the different lay-outs at the many stations covered by our trip. Space and time stand in the way of that pleasant investigation, but the particular arrangement followed at Trenton Channel is of such interest that we give a drawing of it, and direct attention



TRENTON CHANNEL POWER HOUSE

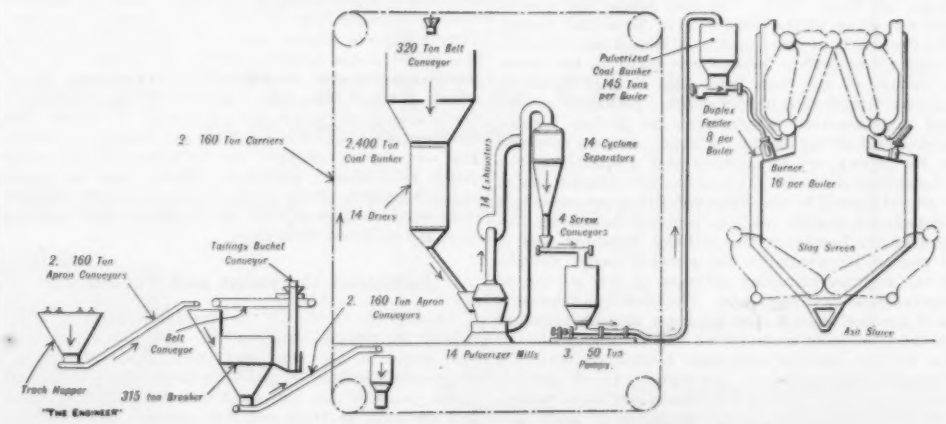
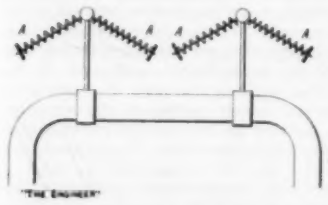


DIAGRAM OF FUEL CIRCUIT AT TRENTON CHANNEL POWER HOUSE

* No. XI. appeared October 7th.

particularly to the steam main which can be seen rising from a long-armed tee piece, connecting the superheaters, thence travelling horizontally, and then, instead of continuing direct to the turbine room, rising in a great inverted U. This view does not show the whole length of the pipe, for at the summit of the U the pipe turns through a right angle before descending. The object of this great swan neck is, of course, to permit free movements of the pipe without straining the joints or pulling on the turbine; but it is manifest that the weight of the pipe must be supported, and, moreover, be supported in such a manner that freedom of movement is not restrained. To meet this requirement a very ingenious spring suspension was devised by one of the station engineers. It is applied to the horizontal portion of the pipe at the top of the U to which reference has already been made. Here is a hand sketch of the device.

At A A A A are suitable rigid supports. Vertical shackles attached to the pipe are taken



SPRING SUSPENSION FOR STEAM PIPE

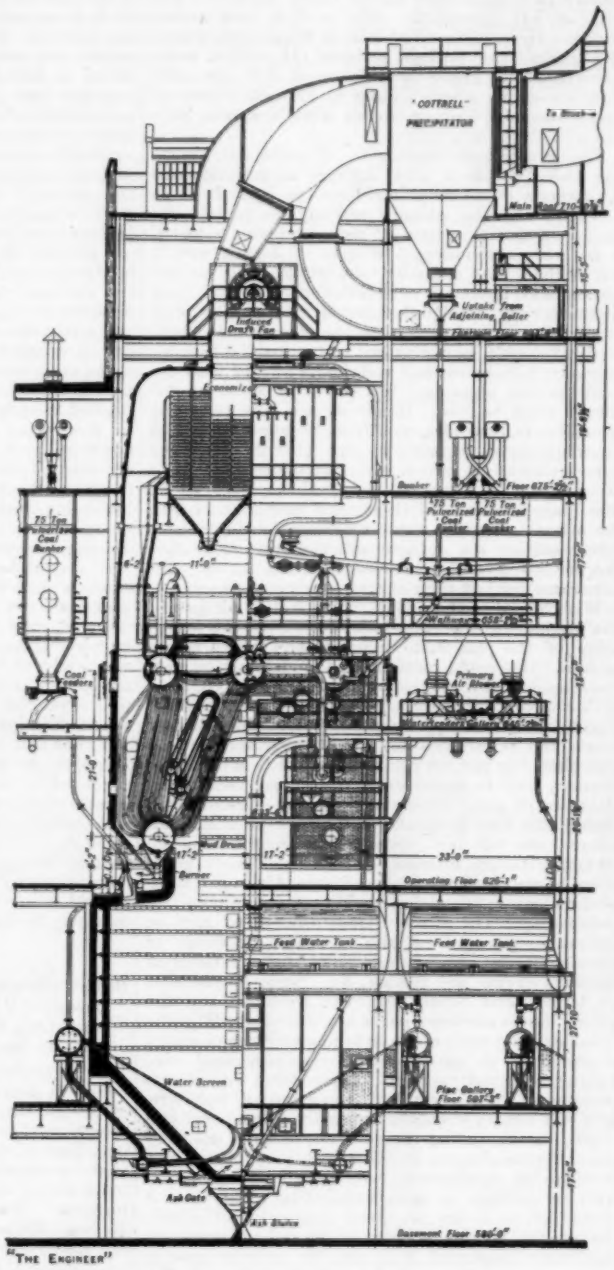
upward to crossheads carried by two inclined helical springs. By careful design of the springs and the angle they enclose, it has, we were informed, been possible to allow for a movement of as much as 6in. with a practically constant tension.

The boilers at Trenton Channel are fired with powdered fuel, sixteen Lopulco burners being fitted to each furnace. The boilers, as will be seen from the accompanying drawing, are of the Stirling "W" type. The evaporating surface is 29,087 square feet, and the superheater surface nearly 19,000 square feet. The area of the water screens at the furnace bottom is 1220 square feet. The furnace walls are air cooled, the hot air being used as the secondary supply for combustion. We need not remind our readers that only half a boiler is shown in the section. With the other half the tube arrangement makes the W, from which the design takes its name. Economisers, it will be seen, are fitted, but no air heaters beyond the furnace walls. The furnace volume is roughly 25,140 cubic feet, and the rate of combustion is about 1·7 lb. per cubic foot, when the boilers are delivering 360,000lb. of steam per hour. That is an interesting figure which we have not had an opportunity to give in connection with other boilers.

Coal comes to the station by rail only, the depth of the water in the channel being too shallow for barges. It is dumped into hoppers, from which it is conveyed to primary breakers, which reduce it to pass through 1¼in. rings. It is then elevated into a bunker, capable of containing 2500 short tons, at the summit of the mill-house. It falls by gravity through vertical driers, meeting an upward current of air heated by passage over steam pipes. In general, the percentage of moisture in the coal is about 4, and this method of drying, which, by the way, keeps down the fire risk, has been found adequate. Continuing its course, the coal enters the mills from which it is exhausted in pulverised form, and, after passing through cyclones which separate it from the air, it enters a screw pump which delivers it to bins beside the boilers. The whole circuit is well shown in the diagram on the opposite page.

In no station which we visited has more attention been paid to the problem of the dust nuisance than in this. The ordinary means of preventing ash emission are employed, but Cottrell precipitators are also being tried in order to trap the last few per cent. Broadly speaking, these precipitators consist of a concrete wall in which steel bars are embedded. Opposite the wall there is a grid of vertical rods, which are charged negatively with rectified current up to a pressure of 50,000 volts. The dust passing into the precipitator is electrified, is attracted to the wall, which is positive at earth potential, and falls or is scraped off by chains. It is estimated that about 90 per cent. of the dust entering the precipitator is captured in this way.

But it is not only the ashes that have to be dealt with. Some fine coal escapes through the ventilators on the bins, and some from the cyclones in the mill-house. It is believed that as much as 1½ to 2½ per cent. of the powdered fuel is lost in this way. If that estimate is not too high, the waste is serious, not only in actual fuel, but in the power expended upon handling and pulverising it. To circumvent the loss an ingenious plan is in contemplation. As much as possible of the dust will be caught in Davidson separators. The air, still slightly charged with powdered coal, will then be allowed to enter an expansion chamber. Here its temperature will fall, depositing its moisture on the coal particles. They will in consequence cohere, and after passing through another Davidson will be returned to the mills.



HALF SECTION THROUGH BOILER-ROOM

From the February, 1927, log of this station we were permitted, by the courtesy of Mr. Parker, to extract a few figures of no little interest:—

Coal, B.Th.U. per lb.	13,490
Coal per kWh (sent out)	1·137 lb.
B.Th.U. per kWh (sent out)	15,340
Plant thermal efficiency, overall	22·26 per cent.
Plant water rate per kWh, net	11·13 lb.
Boiler and furnace efficiency, month	76·7 per cent.
Average daily load factor	66·4 per cent.
Total kWh generated, month	72,014,800

It is the practice in some of the great power stations to issue descriptive booklets for the information of visitors and inquirers. Sometimes they are rather too superficial and popular, rather like the booklets prepared by our own public utility stations, which all too often give more thought to the glorification of town councillors than the plant; but that which is provided by the Detroit Edison Company is a model of what such a booklet should be, and we would strongly advise those who desire to possess a general, but naturally a short, treatise upon the design of the station to secure copies. It was issued in October, 1925, and is therefore not quite up to date in some respects, but on general principles it is as sound as on the day it was printed. We might take this opportunity to add that the great electrical supply companies of America show a freedom in giving details of plant which might with advantage be copied here. In such papers as *Power* and *Power Plant Engineering* one may usually find admirable descriptions which begin from the very initiation of power stations and follow them step by step through their development.

(To be continued.)

The First Screw Propeller.

By Lt.-Col. W. LOCKWOOD MARSH, A.F.R.Ae.S.

THE screw propeller is so associated in the mind with the propulsion of ships that it is natural to assume that when the pioneers of flying came to consider the most efficient means of propelling their craft they merely turned for inspiration to the experience of the older method of navigation. At first sight, therefore, it seems obvious that in embodying the air screw in their design the Wright Brothers and the airship pioneers of fifty years earlier, were merely copying the practice long adopted by shipbuilders. But in point of fact it appears that the exact opposite is the truth, and that those who first applied the screw to ship propulsion were actually plagiarising, albeit unconsciously, the men who a little earlier had invented the balloon and toyed with the idea of making it navigable.

In order to arrive at a correct estimate of the sequence of events it is necessary first to recapitulate briefly the story of the screw propeller as applied to ships, though this is a familiar tale. It is a little difficult to differentiate those who visualised the screw propeller, properly so-called, from the advocates of a multi-bladed instrument more in the nature of a paddle wheel with inclined blades set athwartships, for in the early days the distinction was a fine one. Mr. Seaton—"The Screw Propeller" at page 7—seems to give the credit of originating the idea to Joseph Bramah, who in 1785 took out a patent for a wheel with inclined vanes "similar to the fly of a smoke jack or the vertical sails of a windmill," though he refers to the device described by D. Bernouilli in 1752 as "practically a submerged propeller." Ignoring the fact that from the illustration Bramah's "propeller" appears to have fallen strictly more into the category of paddle wheels, we may pass to the apparently accepted fact that, in any case, it was William Lyttleton who was, in 1794, the first actually to apply the screw to the propulsion of a ship in practice, his propeller consisting of three complete helical "strips or threads" projecting from a cylinder overhanging the frame of the vessel. He, it will be noticed, had gone to the opposite extreme from Bramah in adopting what was in effect three "turns" from an ordinary helical screw. The first person to propose a screw—in the strict modern sense of a propeller with a limited number of blades set in the same plane round a shaft so as to form a portion of a single helix—seems actually to have been John Millington, who in 1816 suggested a screw having "two vanes, each extending to about a quarter of a circle, as they produce a greater effect than any other means."

When we turn to the history of flying we find that the use of the air propeller, both in conception and in actual practice, quite considerably antedates the marine propeller. In the first place, Leonardo da Vinci drew in 1490 a sketch of a helicopter to be raised by a screw consisting of two helices—which idea was put into practice by MM. Launay and Bienvenu, who on May 1st, 1784, exhibited before the Académie des Sciences in Paris a toy helicopter consisting of two superposed four-bladed screws made of feathers. In case it may be objected that the helicopter screw cannot reasonably be described as propulsive, mention may be made of Paucton, who, in his "Théorie de la Vis d'Archimède," published in 1768, described an apparatus called a "Ptériphore," which was to have two screws, one to sustain and the other for propulsion.

But the claim of the air screw to priority does not depend merely upon visionaries—if Leonardo can be so described—or upon its application to toys. It has been generally accepted among historians of flying that Lieutenant (subsequently General) Meusnier, of the Royal Corps of Engineers in the French Army, first suggested the use of the air propeller for the pro-

pulsion of balloons in a complete set of drawings for the design of an airship prepared in 1784, which are now in the Government Aeronautical Museum at Chalais Meudon. The exact date of the completion of these sketches, which must have taken some time to prepare, is not known, though—for reasons that will appear shortly—it is of some interest. There is, however, some reason to suppose that it must have been late in the year from the fact that no mention is made of them in a "Mémoire" on the theory of balloons that Meusnier presented to the Académie des Sciences on July 3rd, 1784.* If this surmise be correct the credit for the origination of the idea may be given to another; who can in any case claim to be the first actually to construct and use an air propeller.

The authority for the early existence of this pioneer screw propeller is a book entitled "Recherches sur l'Art de Voler" by David Bourgeois—a well-known geometrician—which bears the official authority for publication—necessary at that time—under date July 2nd, 1784. The fact that Bourgeois, who was well informed on contemporary effort, makes no mention of Meusnier's schemes is some further evidence that they had not at that date been formulated. However that may be, in a section devoted to "L'Art de Direction," Bourgeois describes an experiment which had already taken place, with an air propeller attached to a boat, and which must therefore have been carried out prior to the beginning of July, 1784. The invention, ascribed to Monsieur Vallet, director of a chemical factory at Javel, outside Paris, is described as a "wheel composed of blades set at an angle (*plans inclinés*) which strike the air without interruption and provide the motion." "I have," Bourgeois says, evidently referring to a personal experience, "travelled up and down the Seine in this boat, which carried a dozen persons. . . . Our outward and return journey took eight and a-half minutes, while another boat propelled by two oars, carrying (only) five persons, took ten minutes to cover the same course." The word "wheel" is, of course, somewhat ambiguous, but it should be explained that the passage comes immediately after one describing in more detail another "wheel," invented by a Monsieur Palmer, with four blades, operated by a man working a crank, which had been tested only in the laboratory. Since Bourgeois describes Vallet's "wheel" as similar and operated in the same way, it is a not unreasonable assumption that it also was a four-bladed propeller—a surmise that can in fact be confirmed from another source, as will be seen presently.

It appears, then, abundantly proved that at some time before July, 1784—ten years before William Lyttleton—an air propeller had been constructed and used, surprisingly enough, to propel a boat; so that not only did the air propeller antedate the marine propeller, but it was actually used first for the propulsion of a waterborne craft. How this came about is explained in "Mémoires Secrets pour Servir à l'Histoire de la République des Lettres en France"—a contemporary record of events published in 1786 — under date October 19th, 1784, where the entry reads:—"Messrs. Alban and Vallet, directors of the inflammable-gas (hydrogen) factory at Javel, have constructed an aerostatic machine. . . . They speak of having discovered an apparatus, which they have tested in a boat, by means of which they can go either forwards or backwards." As a matter of fact, this balloon, known as "L'Aérostat de Javel," was completed and made several ascents during August and September, 1785. Our assumption as to the characteristics of the original experimental propeller tried in the boat receives confirmation from the fact that a wash drawing of the balloon, signed "L. Mays," in the Bibliothèque Nationale in Paris (reproduced in Plate 59 of my book, "Aeronautical Prints and Drawings") shows at the bow a large four-bladed air screw apparently constructed of canvas stretched on a wooden or metal frame.

Literature.

Artificial Fertilisers: Their Chemistry, Manufacture and Application. By P. Parrish, A.I.C., M.I. Chem. E., and A. Ogilvie, A.M.I. Mech. E. Vol. I. London: Benn Brothers. 1927. Price 45s.

This particular volume, which is apparently to be followed by others, deals with the manufacture of soluble phosphates for fertilising purposes, mainly with regard to the application of machinery for mass production. Various notes on the chemistry of the subject are interspersed in various parts of the book. The historical outlines given in the opening pages are meagre in the extreme, and more or less without a purpose. One would expect to find in a book of this bulk, on a subject of inestimable importance to mankind, some sort of account of the economy of the various constituents of the soil and the rendering of those necessary to plant life available to the crops by means of rational tilling, liming, stiffening by added clay, marl, &c., not to forget rotation of crops and periodical intervals for rest for aeration, &c. Science, which gave rise to the artificial fertilisers, is now extremely interested in problems appertaining to making the enormous stores of phosphoric acid and potassium compounds, present in almost all soils, available by methods which induce fine subdivision and the formation of colloids; thus making the necessity to add these compounds in a readily absorbed form less by degrees. Similarly, the fixation of nitrogen by certain microscopic plants living in symbiosis with leguminous plants begins to be a factor in agricultural economy. The more rational farming becomes—*i.e.*, the more care is taken to give the losses back to the land as stable manure, ashes, animal waste products, &c.—the less will be the gap to be filled by artificial fertilisers. With regard to the stores in the soil a few figures may be of use to elucidate the order of magnitude involved. A single hectare of land down to a depth of 15 cm. (6in. approximately) contains 1500 cubic metres of soil, or with a specific gravity of 2 some 3000 metric tons. Each 0·1 per cent. of, say, phosphoric acid or P_2O_5 then means 3 tons, corresponding to 15 tons of 20 per cent. superphosphate. One million hectares (2½ million acres approximately) hence hold for each 0·1 per cent. P_2O_5 something corresponding to 15 million tons of that commodity, or twice the world's annual production.

The stupendous magnitude of geological figures like these makes it very difficult to estimate the importance of artificial fertilisers to agriculture as a whole, and the authors' attempt to explain the causes of the depression of the phosphate industry is not very convincing. In spite of dealing with a few million tons annually, the whole trade in fertilisers and intensive cultivation as a whole have comparatively small influences on the world's total production of foodstuffs. On the other hand, where land is valuable, as in England and in Central Europe, intensive cultivation and reclaiming of bad land are more or less necessary, but prices of artificial fertilisers must be low. Hence we see how Germany specialises on basic slag, modifying her steel production for the purpose, in order to cope with the extensive moor cultivation, which also has made fixation of atmospheric nitrogen a vital problem over there. The inner workings of these local problems explain the erratic nature of trade conditions. Maybe in a future edition the authors will elaborate their first chapter to something more far-reaching on this important subject than the present eight pages.

With regard to the rest of the book, it is all details, the piecing together of which pre-supposes a knowledge of the phosphate industry and other things besides. One could recommend the chapters on rock crushing, grinding and screening to a mining engineer with a clear conscience. To begin with the authors discuss the world's phosphate supply. This chapter treats the occurrence of high percentage calcium phosphates in various parts of the world in a concise manner, and is accompanied by maps, tables and statistics of great interest. Deposits of aluminium phosphates like Redonda and others of a difficult nature, are left out, though they might have an economic future interest. From the figures given it would seem as if the United States, Africa and some of the Oceanic islands so far almost monopolise this commodity. The authors then proceed to give an interesting account of the American methods of mining alluvial deposits and solid rock, methods of washing, drying and storing, &c. Some illustrations of African and South American workings are also given. Some nineteen pages are then devoted to the chemistry and early methods of manufacture of superphosphates. As the process is simplicity itself, viz., mixing a certain amount of powdered tri-calcium phosphate with a certain proportion of sulphuric acid of a certain strength, letting the mixture set in a "den," and grinding the product, there is not very much to enlarge upon, except a fairly complicated case of chemical equilibrium, which is briefly indicated with no pretence to being exhaustive. This is as it should be, as to-day the mass production of soluble phosphates is almost entirely dependent upon the machinery employed, and here the authors give us more and better than most chemical text-books. The first operation, viz., the crushing and grinding of the rock phosphate is essentially the same as met with in connection with mining generally, and the authors describe a comprehensive number of machines for the purpose, discussing their merits with evidently great insight in the practical side of the problems. As an example, may be cited the remark about the old Blake stone crushers in comparison with the rotary type: "For very hard phosphates, such as Curaçao, these crushers, when made of steel, are superior on account of their greater power and strength." The danger to all classes of crushers from "tramp" iron and the use of magnetic separators are discussed in this connection. The Kent and other ring-roll crushers, disintegrators, mills, &c. &c., and the convection of fines by an air current, the use of cyclone dust separators—in a word, almost every modern way of crushing, fine grinding, screening, &c. &c., is dealt with.

A similar lucidity distinguishes the subsequent description of the making of superposphate with mechanical aid, and the use of mechanical "dens." These latter are highly ingenious arrangements for slicing, disintegrating and conveying the superphosphate. Profusely illustrated, this chapter is worthy of close study by every chemical engineer, as it treats a problem which crops up frequently in every branch of chemical manufacture. Like most of the book, it is evidently a compilation of information from various sources, which are not referred to in the text, but the preface summarises the authors' indebtedness to "manufacturers of chemical plant and engineering specialists," which must be very considerable. This is no detriment to the book, which is an excellent one for anyone who desires to find all this information brought together.

After this engineering departure, the authors revert to a chemical question, the methods of dealing with noxious gases evolved when the natural phosphates are acted upon by the sulphuric acid, mainly silicon tetrafluoride, hydrochloric and hydriodic acids. Of these, silicon tetrafluoride is of the greatest importance, both as a nuisance and as a possible source of revenue. Both the legal and economical aspects of the case are well treated, and form very interesting reading, as questions of this kind very often can be the undoing of an industry. After a chapter on storing and treatment generally, the superphosphate theme is completed. Chapter XII., on compound manures and mixing systems, starts thus: "The preparation of compound manures to meet certain specific requirements is an important branch of the artificial fertiliser trade. Of the limited profit made, probably more is derived from this department than any other." Every agricultural authority in the world is up in arms against this way of augmenting profits, as only a very costly system of official control can prevent the putting on the market of fraudulent mixtures as well as legitimate ones. In another place the authors say: "In this connection it must be remembered that it is impossible to guarantee that any particular mixture will be specially adapted to one or another crop under all conditions." This is again an argument against all sale of such mixtures. On the whole, one must remember that the nature of the soil in each case is of as much importance as that of the crop. Dealing with these mixtures does, however, give the authors another opportunity of describing interesting machinery. The book also contains chapters on superphosphate from bones, basic slag, and one on phosphoric acid and double phosphates. It winds up with a forecast of the trend of future developments.

In accordance with the modern custom, the book starts with a Foreword by Dr. H. C. Brown, F.I.C., who holds an important position in a co-operative farmers' manure and chemical company. The reviewer agrees with him that the book is thorough and ought to be valuable to those interested in the technology of the subject. As a book, it is not very well arranged, and it carries the characteristics of a first effort on somebody's part rather prominently, but that can be easily remedied in a future edition. It should be particularly interesting to engineers at chemical works and to chemists desiring to know something about the incredibly complicated machinery necessary to cope with the simplest chemical operations on a truly large scale. One can only wish the authors every success with their work, which must have involved long and careful application to their subject, which includes so many details as to be almost unwieldy to handle, even in this large volume.

British Railway Operation. By T. Bernard Hare. London: "Modern Transport" Publishing Company, Ltd., Norman House, 105–109, Strand, W.C. 2. 7¼in. by 5in. 156 pp. 3s. 6d.

This is an uncommonly interesting and instructive book. It deals with a phase in railway administration on which there is little literature, and yet it is in economies from operation that there lies almost the only hope of salvation for the companies. More than that, operation, if finance be the foundation, is the main corner-stone of the whole structure of railway business. We find, on reference to former annual Railway Returns, that twenty or so years ago, when Mr. Lloyd George, on finding out that British railways were more ably administered than he had thought, encouraged them to adopt co-operation instead of competition as their policy, the ratio of working expenses to receipts was 62. Railways were by no means a successfully paying proposition in those days, as they paid away 12s. 6d. out of every 20s. before the shareholders got anything. To-day, the ratio is 83, a fact that at once shows the seriousness of the question of railway operation and therefore for the necessity of such a book as the present.

We have enjoyed our study of Mr. Hare's efforts, and in that relation frankly confess that we have had surprises at times in finding subjects discussed that we quite expected would have been unnoticed. Of course, with so small a work no feature is dealt with at length, but it may safely be said that, as a reference to the excellent index shows, almost every subject connected with the operation of a railway is covered, and sufficiently for the author's immediate purpose.

Work is being started on a factory to utilise the large deposits of diatomaceous earth at Digby Neck, Nova Scotia. It is estimated that there are at least a million tons of the material available.

* Richard Crosbie also proposed and possibly made use of "flyers"—like the sails of windmills—in 1784. See Hodgson's "History of Aeronautics in Great Britain," p. 187.—Ed. The E.

The Lanarkshire Hydro-Electric Power Scheme.

No. III. (*Conclusion*).*

IN the Supplement published in this week's issue the general arrangement of the Bonnington power station and a sectional elevation of one of the turbines at Stonebyres are shown. As already indicated, the two stations are designed on very similar lines. But whereas at Bonnington the turbines are provided with cylindrical balanced valves, as illustrated in the Supplement, at Stonebyres they are directly connected to the pipe lines. Owing, moreover, to the length of the pipe lines at Bonnington, it was necessary to provide the sets at that station with automatic relief valves. The main difference in the two stations will readily be understood on comparing the general arrangement shown in the Supplement with the plan of the generating units at Stonebyres shown in Fig. 21. A plan of one of the turbines in the Bonnington station is given in Fig. 22; whilst Fig. 23 shows the runner and shaft, the lower guide ring and the vanes mounted upon it.

The gate apparatus consists of twenty cast steel guide vanes cast in one piece with the stems, and they rotate in bronze bushes lubricated from the outside by means of lubricators, to be seen in Fig. 20 in our previous article. Large collars at the junctions of the vane body with the stems protect the latter against wear. The vanes are carried at their upper ends by the operating levers, which slide on well-lubricated surfaces out of the reach of the water. The levers and links connecting the guide vanes to the regulating ring are of the so-called "offset" type, designed to reduce the force required from the governor by making the servo-motor stroke more or less proportional to the quantity of water shut off or admitted by the vanes, thus improving the regulation. The connecting links are designed so that in the event of an obstruction preventing one of the vanes following the movement of the regulating ring, the link will break long before the elastic limit of any part of the gate apparatus is reached. The connecting link pins are made excentric, so as to allow of slightly varying the distance between the pin centres, with the result that it is possible to adjust the relative position of the guide vanes, so as to increase the tightness of the gate apparatus when closed. This can be done not only in the shops but also on site, in order, for instance, to take up wear. Both parts of the gate apparatus are made of steel. The top part consists of a forged steel lining ring fixed to the main turbine cover and the bottom part of a guide ring bolted to the speed ring. The runner, shown in Fig. 24, has steel plate vanes, ⅜in. thick, cast into a steel brown and rim. The runners at the Stonebyres station each weigh 2 tons 2 cwt., and each has a diameter of 5ft. 7in., whilst those belonging to the turbines at the Bonnington station are slightly smaller. In both cases the design was based on experimental data, with model runners specially made for the job. The steel plates for the vanes were accurately shaped between dies; they were made very smooth, and their edges were stream-lined. In the runner crown balancing holes are provided so as to reduce the hydraulic thrust by eliminating the leakage water. The crown and rim are protected by cast steel rings, and a guide cover is fixed to the underside of the runner so as to lead the water smoothly to the draught tube. The runner is bolted to a solid forged flange at the end of the turbine shaft, and the whole of the torque is transmitted to the shaft by a "laid in" key, the fixing studs simply working under tensile stress. For the purpose of centring, a spigot is provided.

The main cast iron turbine cover is stiffened by heavy ribs. It is bolted to the speed ring and carries the regulating ring, the guide bearing and the shaft stuffing-box. The cast iron regulating ring slides on bronze pads which, apart from the rotation, allow a slight displacement of the ring as required by the movements of the two rods of drawn steel tubing, to be seen in the drawing, Fig. 22, and which are connected to the governor. The guide bearing, which is 12in. in diameter and 30in. long, consists of a bush lined with white metal, split in both the vertical and horizontal planes to facilitate dismantling, and of a heavy cast iron supporting frame. In order to obtain the greatest relinbility a gear drive was chosen both for the governor actuator and the lubricating oil pump, which is arranged in the oil sump on the turbine cover, and which feeds the generator and turbine bearings. A machine-cut spur gear wheel clamped to the main turbine shaft meshes with a pinion fixed on the vertical oil pump shaft, which drives the horizontal actuator shaft through bevel gears. With this arrangement the slight axial movements of the main shaft caused

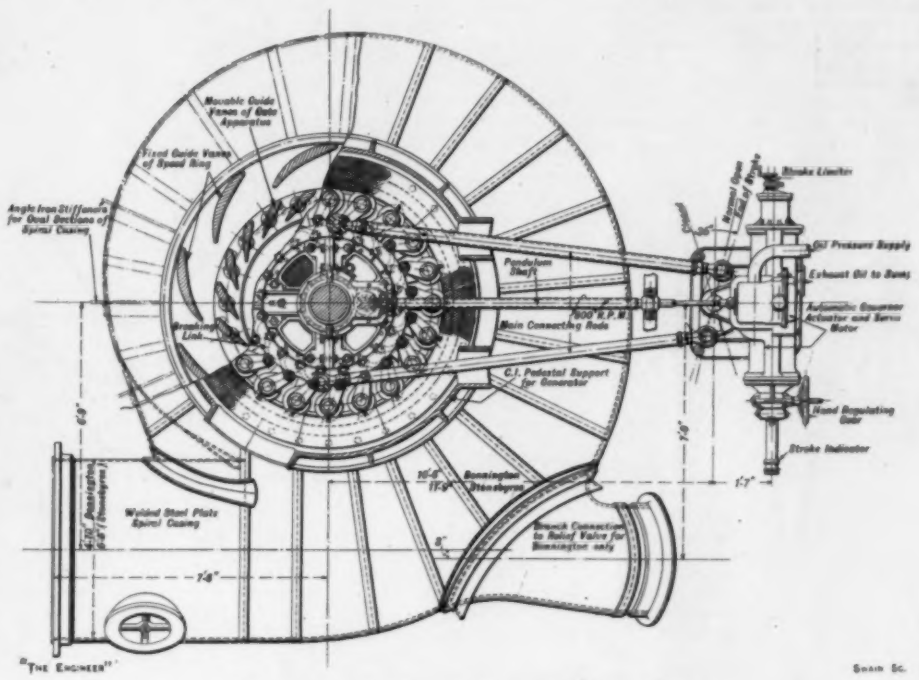

Movable Guide Vanes of Gate Apparatus
Fixed Guide Vanes of Speed Ring
Angle Iron Stiffeners for Oval Sections of Spiral Casing
Pendulum Shaft
Governing Link
Main Connecting Rods
500 R.P.M.
C.I. Pedestal Support for Generator
Stroke Limiter
Oil Pressure Supply
Exhaust Oil to Sump
Automatic Governor Actuator and Servo Motor
Hand Regulating Gear
Stroke Indicator
Bonnington Stonebyres
Welded Steel Plate Spiral Casing
Branch Connection to Relief Valve for Bonnington only
"THE ENGINEER"

FIG 22—PLAN OF TURBINE AT BONNINGTON STATION

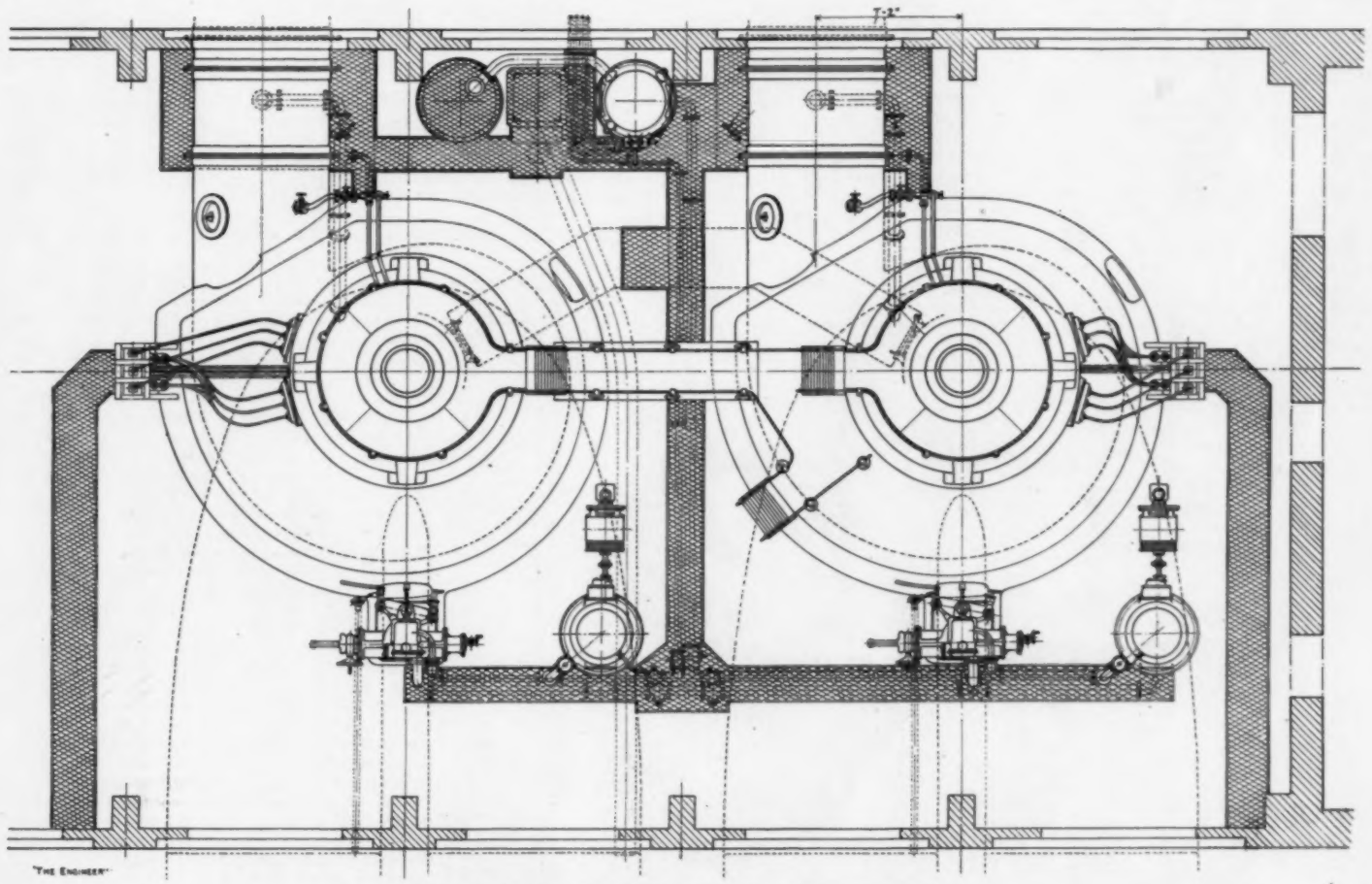


FIG 21—PLAN OF GENERATING UNITS AT STONEBYRES STATION

* No. II. appeared October 7th.

by changes of load on the turbine, do not affect the meshing of the gear teeth, all of which are immersed in an oil bath, and are completely enclosed in a dust-proof gear-box bolted to the top of the turbine bearing.

Where the turbine shaft passes through the main cover, there is a stuffing-box containing lubricated graphite rings, which form the tightening material. At both ends of the shaft, which is composed of special Siemens-Martin steel, there is a solid forged coupling flange with a spigot for centring, and the torque is transmitted by "inlaid" keys, the fixing bolts working solely under tensile stress in the manner already described.

The draught tube is of the English Electric Company's spreading type. It consists of a smooth vertical expanding tube extending down to a para-

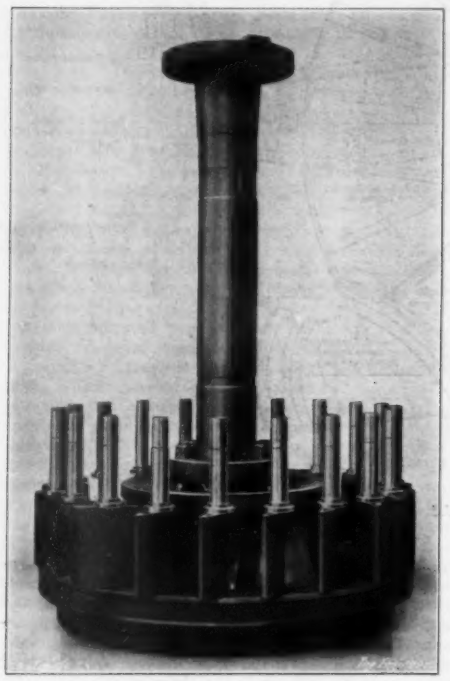


FIG. 23—RUNNER AND GUIDE VANES

bolic chamber with a flat bottom. Before the water is turned through a right-angle its velocity has been considerably reduced, thereby minimising the loss arising from eddies when the change in direction occurs. At the same time the flat bottom of the tube causes the water to spread out rapidly, thereby converting a considerable portion of the remaining velocity into pressure in the horizontal portion of the draught tube. A watertight door, reached by a gallery under the sets, is provided in the draught tube liner, in order to enable the runner to be inspected. For shutting down the sets in the Stonebyres station provision was originally made for mechanical brakes, but experience showed that they were unnecessary, because a considerable breaking effect is produced by the high specific speed runners churning the water at the top of the draught tube. At Bonnington, however, where on account of the greater output of the sets the inertia of the rotating parts is larger, hydraulic brakes are provided. A nozzle directs a jet of water on to the underside of the runner vanes, the angle between the jet and the vanes being such that a considerable breaking force is exerted and the set is rapidly brought to rest.

The cylindrical balanced stop valves at the Bonnington station are operated by the pipe line water pressure. Their control gear, which is to be seen in

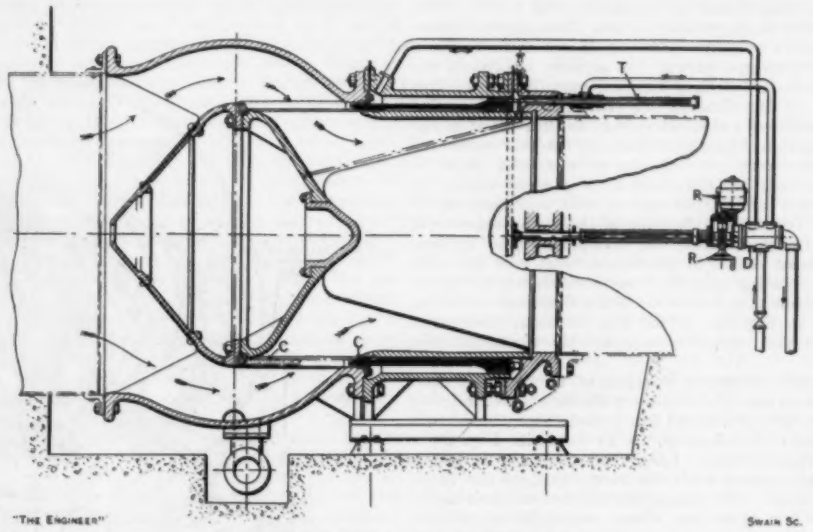


FIG. 25—CYLINDRICAL BALANCED VALVE

Fig. 25, consists of a distributing valve D with return motion gear R, designed for hand or electric remote control from the power station switchboard. Since the return motion gear allows of opening the valves by any desired amount, no by-pass is provided. Thus, when starting up the turbines, the valves are "crack" opened, and only when the pressure in the spiral casing has reached the normal value, is the remainder of the opening stroke performed. Cylindrical balanced valves of this type were chosen in order to obtain complete security as they can be operated under any conditions of flow. They will not, in fact, fail to close in the event of the flow reaching an abnormally high velocity, as would occur in the event of a turbine racing or in the event of the bursting of the casing. Even under those conditions their motion would be controlled so as to prevent water hammer in the pipe line. The closing apparatus C is in the form of a cylinder, and is efficiently guided over the whole stroke, its rate of travel being controlled by a travelling control valve T, which gradually slows down the motion, so that the last part of the closing

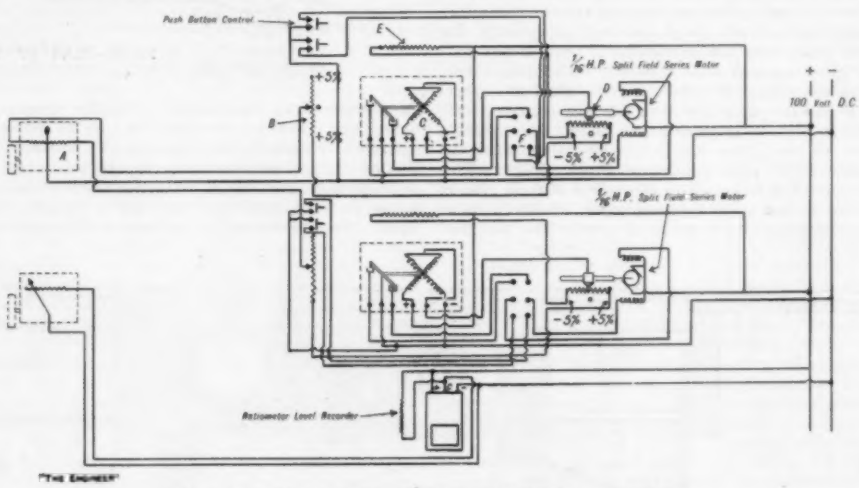


FIG. 26—DIAGRAM OF CONNECTIONS OF CONTROL APPARATUS

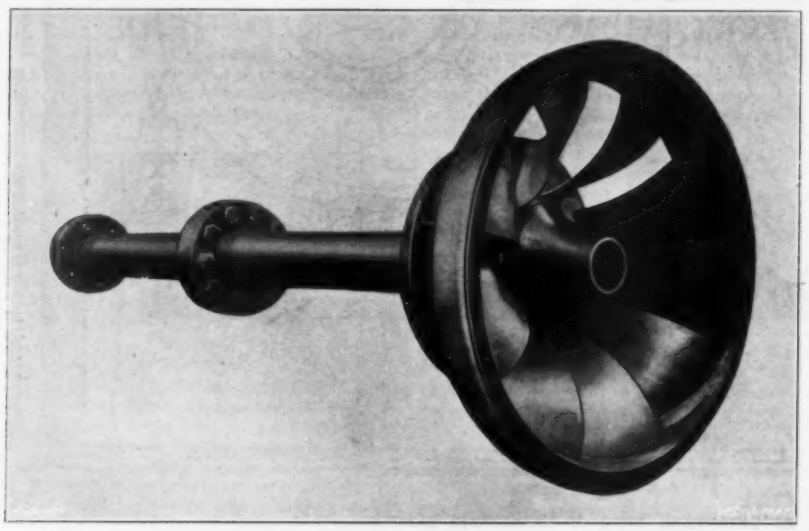


FIG. 24—RUNNER OF TURBINE

stroke is performed very slowly, so as to eliminate any chance of the valve slamming, with consequent water hammer in the pipe line. Similarly, the reverse operation is brought about by this same travelling control valve, which eliminates "slam-opening," the valve cylinder moving through the first part of the stroke very slowly and accelerating its speed as the opening increases. The area of the closing cylinder or piston which is in the water stream is comparatively small, with the result that the valve can be safely closed in cases of emergency because the forces on the valve are very little affected by the pressure of the water flow. The Bonnington valves are made of cast iron, but they have bronze seating rings, and guiding strips of the same material are provided for the closing cylinders.

At both stations the speed of the sets is controlled by oil pressure governors of the English Electric Company's standard type, and they have standard actuators with servo-motors designed to supply the power required. As already mentioned, the actuator pendulum is gear-driven from the turbine shaft, and to prevent vibration an elastic member is incorporated in the drive. The pendulum is very sensitive and the compensation of its action is not proportional to the stroke of the compensating mechanism, but is increased round the neutral position, resulting in a very quick and steady regulating action. The actuator is designed so that the speed can be kept constant for all positions of the servo-motor, but as a certain amount of speed variation is required to distribute the load between the sets running in parallel, it is fitted with a device which allows up to 4 per cent. difference in speed between full load and no load. Moreover, to allow of paralleling the sets, the normal speed can be varied within the limits of plus or minus 5 per cent. either by hand or by remote control gear operated from the switchboard. If for any reason the main pendulum should be thrown out of action, an emergency pendulum will shut down the set after the speed has increased above or dropped below the normal value by more than 30 per cent. This pro-

tective gear therefore shuts the turbine down in the event of a runaway or in consequence of a failure of the governor drive. The actuator mechanism is completely enclosed in a dustproof casing, and all its moving parts are continually lubricated. The servo-motor, which is of the double-piston type, is provided with hand gear, which can be clutched in or out at any position of the stroke, and it also has a stroke limiter for limiting the turbine output to any particular value. Power from the servo-motor is transmitted by a cast steel rocking lever, and two connecting-rods directly to the regulating ring, as shown in Fig. 22.

The oil under pressure for operating the governor is taken from an air pressure receiver supplied with oil and air by a two-stage rotary gear pump driven by an electric motor. In order to maintain an adequate air cushion in the receiver, the pipe feeding the pump with air is arranged just above the correct oil level in the sump. When there is too much oil in the receiver this pipe is uncovered and air is pumped; but when, on the other hand, there is too little oil in the receiver,

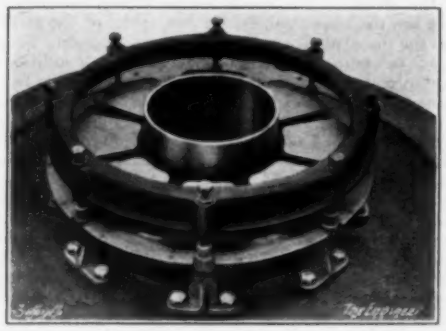


FIG. 27—THRUST BEARING

and therefore too much oil in the sump, the pipe is sealed and only oil is pumped. In order to minimise wear on the pump, a relief and by-pass valve is provided, which, when the correct pressure has been reached in the pressure receiver, connects the delivery side of the pump with the exhaust. The pump then runs unloaded, but when the pressure drops below a certain value, the valve again connects the pump with the receiver. As the two pressure receivers in each power station are interconnected, in the event of one pumping set being put out of commission, oil under pressure for both receivers can be drawn from the remaining set. At Bonnington the governor not only controls the regulating ring of the turbine, but it is also connected to the control gear of the relief valve, which, in the event of the quick closing of the gate apparatus, opens and by-passes the water rejected by the turbines into the tail race. This quick regulation of the input to the wheel results in a relatively small rise in speed when the load is thrown off the generators, and it also prevents an undue pressure

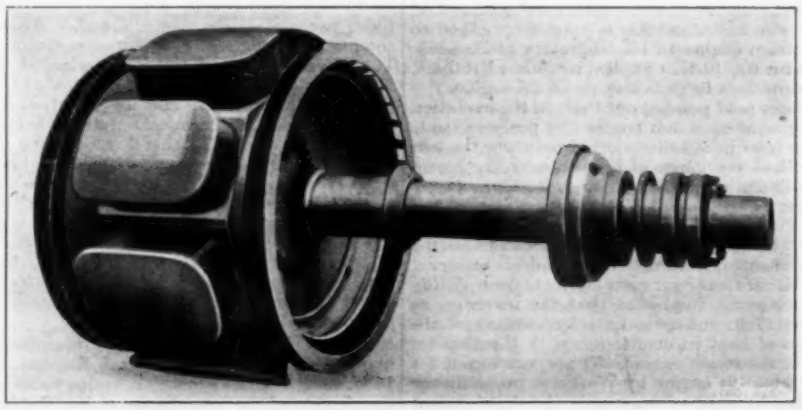


FIG. 28—GENERATOR ROTOR

rise in the pipe line. The relief valves are of the English Electric Company's cylindrical balanced type designed on lines similar to those of the main valves. The bend usual in other types of valves is eliminated, and the valves have been arranged as direct extensions of the pipe lines. Another advantage of these valves is that they discharge the water in the form of a hollow cone, thereby causing it rapidly to lose its kinetic energy, as the result of air friction and to reach the tail race in the form of a spray, thus rendering special protection of the tail race unnecessary. The single floor design of power station adopted allowed the main and relief valves at Bonnington and the whole of the control gear at both stations to come under the main crane hook. Moreover, this design also allowed the actuators to be mounted on the servo-motors, instead of having to arrange them as two units on different floors, as is usual with vertical shaft sets—an advantage which becomes apparent when it is remembered that a large distance between the actuator and servo-motor often leads to trouble on account of pressure rise in the connecting oil piping and deformation of the complicated return motion gear.

Owing to the considerable variations in the quantities of water discharged by the river Clyde, and the absence at present of any appreciable amount of water storage, special arrangements have been adopted to utilise all the water available and effectively to safeguard against running the intakes dry.

The system employed for this purpose is believed to be unique. The apparatus was supplied by George Kent, Ltd., of Luton, to the specification of the English Electric Company, Ltd. A complete set of apparatus for one turbine consists of a transmitter A—Fig. 26—installed at the intake, a synchronising rheostat B mounted on the machine switchboard, a ratiometer relay C, which controls the speed-setting motor of the turbine governor and a rheostat D, mounted on the turbine governor, having its moving contact actuated from the speed index pointer. The transmitter consists of a variable resistance, the value of which is altered in accordance with the variations in the water level. A copper float resting on the surface of the water operates by means of a flexible copper cord, a wheel mounted on a spindle, to which the moving contact arm is geared. Incidentally, the contact arm also serves as a direct mechanical water level indicator, a pointer to be seen in Fig. 26 traversing a scale graduated in suitable units. By means of line wires the transmitter is connected in series with the synchronising resistance B, which is an ordinary 100-way switchboard rheostat, and which under normal running conditions is left in the mid position. Two other resistances are connected in series with the above-mentioned resistances, one of which is mounted directly on the turbine governor. The other is a fixed balancing resistance shown at E.

All these resistances are connected in series across the 100-volt mains supplied for the station battery, and the contact arm fixed to the governor speed index divides the total resistance into two parts. The ratiometer relay is connected across these two parts of the total resistance, the common terminal being connected to the moving contact on the speed index. The complete circuit takes the form of a Wheatstone bridge network, with the result that its operation is unaffected by voltage variations. The values of the various resistances are proportioned so that when the water level is midway between the operating limits and the synchronising rheostat is in its normal running position, the relay will cause the speed adjustment motor to set the speed index to the mid position, and under these conditions the network is balanced. The speed-variation device on the turbine governor is capable of varying the no-load running speed within the limits of plus or minus 5 per cent. of the synchronous speed, and when the water available allows of an increased output the speed-varying device is moved so as to tend to increase the speed. But as the alternator is tied to the system with a constant frequency of 25 cycles per second, an increase in speed cannot occur and the load increases instead. When therefore

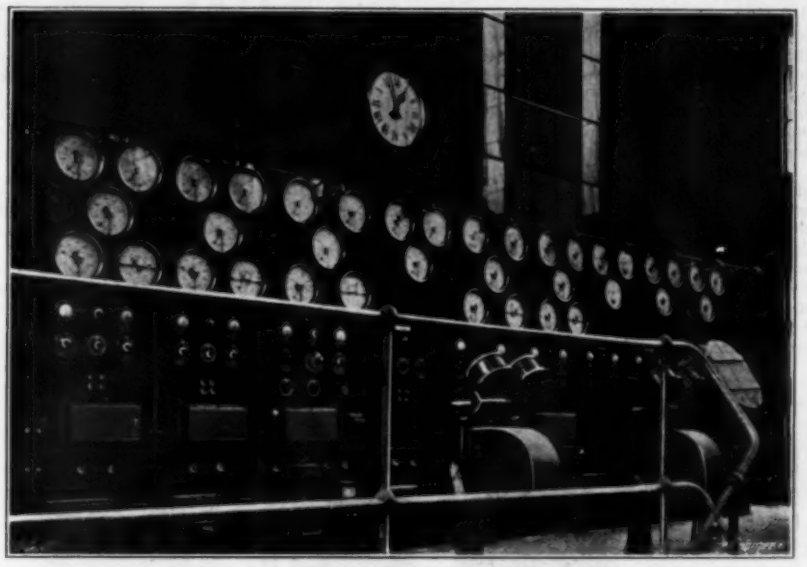


FIG. 29—MAIN SWITCHBOARD

the water level rises and more water consequently becomes available, the transmitting resistance will be varied and the balance of the circuit will be disturbed. The relay will consequently start the turbine speed variation motor, which alters the speed setting until a balance is again obtained. An increase in the speed setting of the governor will, of course, automatically increase the load on the generator, whilst a decreased setting corresponding to reduced water level will reduce the electrical load. The synchronising rheostat acts as a hand-operated transmitter, which is only used to adjust the speed of the turbine for synchronising purposes, it being afterwards returned to normal position, so that the load on the generator is automatically adjusted in accordance with the amount of water available. Both sets of control gear on the two turbines are operated by one transmitter—as shown in Fig. 26—the moving contact arm of which is connected to one pole of the supply and acts as a common feeder to both circuits. An additional transmitter, actuated independently from a separate float, operates an electric level recorder of the ratiometer type in the station, and enables the operation of the automatic gear to be checked. The double-pole double-throw switches, shown at F on the diagram, are for changing over from automatic to push-button control.

Details of the outputs, speed, voltage and periodicity of the three-phase generators in the two stations have been given. In both cases, the machines generate 25-cycle current, but they have been constructed so that they can be converted into 50-cycle generators with a minimum amount of trouble. To facilitate transport, the stators are split. The upper guide bearing and the thrust bearing are carried on a bracket with arms secured to the generator frame. The thrust bearing—shown in Fig. 27—is surrounded by an oil bath and is water cooled. It carries the weight of the generator rotor and runner and also deals with the hydraulic thrust on the runner. The circular generator bed-plate is mounted upon the concrete pedestal that surrounds the inner cast iron cone-shaped support which rests upon the turbine speed ring. The concrete pedestal and foundation are strongly reinforced. The exciter frame is supported from the top bearing bracket, and the exciter armature is mounted on the alternator shaft. The rotor body consists of a steel casting shrunk on to the shaft, and has dove-tailed grooves for carrying the laminated steel poles, which are clamped between manganese bronze end plates. All the revolving parts are designed to withstand a runaway speed 90 per cent. in excess of the normal speed. A view of the rotor is given in Fig. 28.

In order to show the degree of opening of the surge tanks sluice gates at Stonebyres, an electric indicating device has been installed. At each of these sluice gates there is a step-by-step electrical transmitter connected to indicators in the power station. Each of the graduations on these indicators can be illu-

I

minated by an electric lamp. During the operation of the sluice gates these lamps light up in succession and give indications of the positions of the sluice gates at any moment.

The English Electric Company's 11,000 volt switchgear at each station has a rupturing capacity of 250,000 kVA. Each switch is enclosed in a moulded stone cell with moulded stone barriers between the phases and screened by sheet steel doors. There are duplicate sets of bus-bars with change-over selector switches for each generator and feeder. The main switchboard from which all the switches are controlled on the electrical remote control system, is shown in Fig. 29. The north interconnector, consisting of a six-wire overhead line on one line of poles, will connect the Bonnington Power Station with the existing 11,000-volt network of the Clyde Valley Power Company, at the Overton switch-house. The cross-section of each conductor is 0·15 square inch, and the line will be arranged as a 0·3 square inch split conductor line. The route traversed will be through the Burgh of Lanark, the village of Braidwood, the town of Carluke and the village of Law. At all these points arrangements will be made to give a supply. The drop in the transmission line voltage will be compensated by means of a 470 kVA booster at Bonnington, designed to give a boost of 815 volts. This booster has its windings split so that it may form part of the split conductor protective scheme. A transmission line, also consisting of six 0·15 square inch conductors on one line of poles, connects the Stonebyres Station with the Motherwell Power Station of the Clyde Valley Power Company. This line traverses the country on the south side of the river, through an important colliery district, and

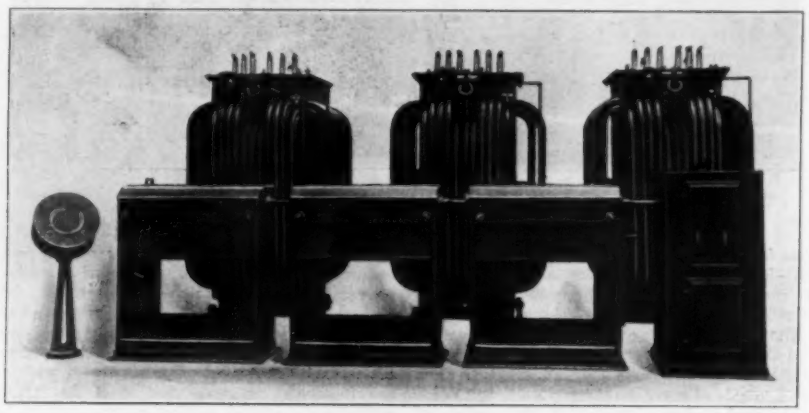


FIG. 30—BOOSTER TRANSFORMERS FOR REGULATING GEAR

passes through the outskirts of the town of Larkhall, which is to have a supply. The line will also act as the supply point for branch lines running to the town of Stonehouse and Strathaven.

Two boosters, each of 394 kVA capacity, for compensating the line drop and capable of giving a combined boost of 1370 volts have been installed; one at Stonebyres Station and the other at the Motherwell Station. A third transmission line consisting of six conductors, each of 0·2 square inch cross-section, on one line of poles, also connects the Stonebyres and Motherwell Power Stations. This line is connected as a split conductor feeder with boosters of 580 kVA capacity at the Stonebyres and Motherwell Power Stations, and these boosters are capable of giving a combined boost of 1500 volts. Two interconnectors, each of 0·2 sq. in. section, and consisting of two three-wire lines on separate pole routes, will connect the Bonnington and Stonebyres Power Stations. In order to compensate for the slight voltage drop between the stations, the plant at Bonnington is to operate at 11,300 volts, whilst that at Stonebyres works at 11,000 volts.

Each of the boosting transformers consists of three single-phase English Electric oil insulated self-cooled units—as illustrated in Fig. 30—which shows the boosters in the English Electric Company's works. The drum type Brookhirst switchgear associated with these boosting transformers, to be seen in the foreground, is also oil immersed, and it is totally enclosed in iron pillars, each phase being an independent unit, but they are coupled together mechanically by means of shafting and universal joints. Each set of three single-phase units is coupled by means of this shaft to a motor operating pillar, which is controlled from the switchboard by means of push buttons which are connected to contactors in the motor operating pillar.

THE IRON AND STEEL INDUSTRY.—If we cannot, with honesty, say that we welcome the appearance of yet another addition to the over long list of technical journals, we may at least congratulate the Louis Cassier Company, Ltd., on the style in which *The Iron and Steel Industry and British Foundryman* is produced, the first issue of which lies before us. It is, in fact, the monthly supplement to the *Metal Industry*—which bore the same name—in a separate existence. It will be devoted solely to the interests of iron and steel, and will make a special appeal to those trades. We wish it every success.

The Transfer of Heat in Cylinder Walls.

No. I.

THE first of a series of four lectures to be delivered at the Institution of Civil Engineers upon the subject of the transfer of heat in the cylinders of reciprocating engines took place on Tuesday, the 11th inst. The lectures were arranged by the Faculty of Engineering of the University of London, under a scheme by which scientific and technical men of distinction in other countries are invited to lecture in English upon their work. In the present instance Professor Dr.-Ing. Adolph Nägel, of the Technische Hochschule, Dresden, the well-known authority on the Diesel engine, is the lecturer. Sir Henry Fowler, K.B.E., the President of the Institution of Mechanical Engineers, took the chair and introduced Professor Nägel. Other lectures take place to-day, Friday, and on the 18th and 21st inst. at 5.30 p.m.

Opening his lecture, Professor Nägel expressed his pleasure at being invited to lecture upon his work in London, and, in particular, in that country in which the great pioneers of mechanical engineering, James Watt, Hornblower, Woolf, and others struggled and were successful. In proceeding, the lecturer divided his subject into four main parts: the first two lectures are devoted to the development of the methods of studying the heat transfer in both steam and internal combustion reciprocating engines, and are largely historical; in the last two the lecturer will speak concerning his own experiments and results. He has developed a new method of recording the rapidly varying temperatures of the working substances and of the cylinder walls, and has applied the method to a uniflow steam engine in his laboratory at Dresden. His apparatus was further applied by Sulzer Brothers, at Winterthur, to a large two-cycle Diesel engine.

The lecturer next pointed out that, in the evolution of the reciprocating steam engine the progress made has always been in the direction of reducing the loss caused by the interchange of heat between the steam and the cylinder walls. The first step was taken by James Watt in his patent No. 913, of which it was stated by Professor Matschoss, the German technical historian, "that it might be regarded as one of the most important documents of technical history." Professor Nägel then read some extracts from Watt's patent in order to emphasise that the inventor, as far back as 1769, understood the importance of the interchange of heat in connection with the thermal efficiency of the steam engine. The separation of the condenser from the engine by Watt was probably the greatest step forward ever made in the development of the steam engine. This step has been followed, successively, by compounding the expansion, by the use of superheated steam, and by the introduction of the uniflow engine.

It is remarkable, after the work of Watt, that nearly one hundred years elapsed before the investigations of Rankine, Hirn, and Zeuner made it possible to show quantitatively the importance of the losses caused by the interchange of heat between steam and wall. Their work was, for the most part, based upon the results of tests carried out by Hirn at his works at Logelbach, in Alsace, in 1874 and 1875. The data available was insufficient. Some years passed before tests sufficiently accurate to be of value were made. In the meantime more had become known of the coefficient of heat transfer between a gas and a metal, and of the coefficients of thermal conductivity of metals. The lecturer asserted that the scientific treatment of the problem should not end with the determination of the heat quantities interchanged, but that the causes of this interchange should be discovered.

Efforts to investigate the problem really scientifically began about 1884, and upon the work from that date onwards Professor Nägel spoke in greater detail. He pointed out that, at any instant, the interchange of heat between steam and wall at any point of contact depends, first, upon the temperatures of steam and wall at the point in question, and secondly, upon the coefficient of heat transmission or transfer. Under uniform conditions of running there exists, at each point of the wall, a certain mean temperature which corresponds to the condition that the heat supplied by the steam to the point is equal to the heat conducted from this point of the wall to the outside, in accordance with the law of heat conductivity. On account of this, the mean temperature of each point of the wall compared with the mean temperature of the steam in contact with it is dependent on the temperature of the outside of the wall, the wall thickness, the coefficient of heat transmission, α and the coefficient of heat conductivity, λ, of the metal of the walls. The bigger the value of α the more the mean temperature of the wall will approach that of the steam; the greater the coefficient of conductivity λ of the wall the lower will the mean temperature of the wall, under the same conditions, fall below that of the steam. The mean temperatures referred to here are the mean values, for one cycle, of the steam and the metal at any point under consideration. These mean temperatures will, under uniform conditions, remain constant at each point, but will change from point to point under the influence of the design of the cylinder, the engine speed, the point of cut-off of the steam, the speed of the engine, the condition of the admission steam, and so on. From the mean temperatures of the walls, which may be assumed to be determined at a sufficient number of points of the wall, inside and outside, the heat quantity which is conducted through the cylinder wall to the outside may be calculated. This heat is delivered from the outer surface of the walls to the immediate surroundings and constitutes a loss. In addition to the heat quantity passing to the outside, there is, at each point of contact of steam and wall, another heat quantity of great importance. This is the heat transferred from the steam to the wall at one part of the cycle, when the temperature of the steam exceeds that of the wall, and which is transferred back from the wall to the steam at a later part of the same cycle, when the wall temperature is higher than the steam temperature. Whilst the first quantity flows only in one direction, the other changes its direction, to and fro, giving an oscillating or fluctuating heat quantity. The magnitude of this latter quantity at each point of the wall and at every instant—or at every crank angle—will depend upon the temperatures of the steam and wall momentarily existing. Under this influence the temperature of the inside of the cylinder wall will rise and fall. These changes of temperature, following the laws of heat conductivity, will continue into the interior of the wall, but diminishing rapidly in magnitude with the depth.

Professor Nägel intends to deal fully with these actions in his third and fourth lectures and will show that this fluctuating heat quantity is, by far, the chief cause of reduced thermal efficiency in reciprocating steam engines, and that the heat transmitted directly through the walls has a relatively smaller influence.

Grashof, in 1884, and Kirsch, in 1886, deserved credit for having first determined mathematically these two quantities, which together constitute the complete exchange of heat between steam and wall. The physical laws of the conduction of heat were deduced mathematically from Newton's fundamental principles by Fourier. This investigation is included in his chief work, "Théorie Analytique de la Chaleur," published in 1822. To this day Fourier's method of analysis is used. The progress to be noted in this field since 1884 consists almost wholly in the accumulation of experimental data. In dealing with this matter Professor Nägel referred to a lecture delivered by Professor Wilhelm Nusselt, of Munich, at a meeting of the Heat Transfer Committee of the Verein Deutscher Ingenieure in January, 1926, which is shortly to be published as a Forschungsheft by the V.d.I.

Grashof, in his paper on "The Transmission of Heat in the Cylinder Walls of Steam Engines," Z.V.d.I., 1884, using Fourier's methods, endeavoured to deduce the process of the interchange of heat between steam and wall from the conduction of heat in the interior of the wall. In the lack of reliable test data, Grashof made certain assumptions concerning the temperatures in the wall, in order to simplify his calculations. He took the temperature of the inner wall in contact with the steam during admission and expansion to be equal to that of the admission steam. On the return stroke he assumed both the temperatures of the steam and the inner wall to be that of the condenser. As a result of his deliberately neglecting the variation of the steam temperatures during the two strokes, and by assuming no fall of temperature between the steam and the wall, he introduced into his calculations an infinitely large coefficient of heat transfer between steam and wall.

Kirsch, a professor at Chemnitz, attempted to correct the assumptions of Grashof and to approach more closely to the actual facts. His work, entitled "The Movement of Heat in the Cylinder Walls of the Steam Engine," appeared in 1886 (see also Z.V.d.I., 1891). In his treatment, Kirsch assumed a periodic variation of the steam temperature (which, like Grashof, he took to be the same as the inner wall),

and, by the Fourier method, he computed analytically the effect of this variation. He came to the conclusion that the quantity of heat interchanged between steam and wall is inversely proportional to the speed of the engine. This, of course, is in agreement with the fact that the influence of the walls decreases with increase of engine speed. By neglecting the resistance to heat transfer between steam and wall, *i.e.*, by assuming an infinitely large coefficient of heat transfer, Kirsch obtained values for the heat interchanged that are too high.

Professor Nägel next referred to the work of Professor A. Fliegner, of Zurich, who in 1897 published in the *Schweizerische Bauzeitung* an extensive paper entitled "The Transfer of Heat Between the Steam and the Walls of the Steam Engine." Fliegner introduced a coefficient of heat transfer. He gave a formula in which the quantity of heat interchanged during the working process was reduced, as the value for the coefficient of heat transfer was reduced. At the same time the quantity of heat per cycle flowing through the walls diminished greatly with an increase of speed. Fliegner applied his method to data which had been obtained from tests on a steam engine at the Polytechnikum in Zurich. He found the coefficient of heat transfer to have the value 414,000 K. cal. per square metre per hour, a value which he deduced from an investigation upon an indicator card taken from the same engine. In this, he supposed that the temperature of the wall, during admission of the steam, averages about 1·3 deg. Cent. less than the temperature of the dry saturated steam with which the engine was supplied. This deduction, which assumed much too high a temperature of the wall, as later tests have shown, caused the chief error in Fliegner's calculations, in that they are based on much too high a value of the coefficient of heat transfer. With superheated steam Fliegner used a coefficient of heat transfer equal to 41, a figure he computed from the transfer of heat between the furnace gases and the walls of a boiler. With this value he calculated the maximum fluctuation of temperature which may occur at the inner wall in the case of superheated steam; he found it to be less than 2 deg. Cent. In his paper he quoted some direct measurements of wall temperatures published by M. E. T. Adams, an American engineer, in *Cassier's Magazine* in 1895. In those tests a thermo-couple was used and inserted into holes bored to within 0·25 mm. of the inside wall.

About the same time Bryan Donkin read a paper before the Institution of Mechanical Engineers entitled "Experiments on a Vertical Single-cylinder Steam Engine, With and Without Steam in the Jackets, Condensing and Non-condensing, Double and Single-acting, at Different Expansions with Saturated and Superheated Steam." The engine in question was erected in 1889 in the works of Bryan Donkin and Co., Bermondsey, as a test engine. In the space of eighteen months some one hundred and fifty tests were made, the remarkable and far-reaching results of which are given in the paper in the form of diagrams.

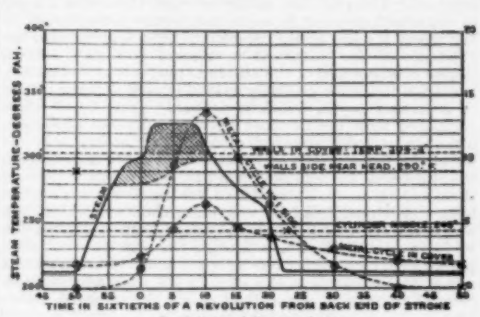
From these tests Professor Nägel referred only to the fact that in eight tests of Series 6 and 7—four tests with saturated steam and four with superheated steam—without steam in the jackets, the mean temperature of the inner wall was from 12 deg. to 27 deg. Cent. lower than the temperature of the admission steam when saturated steam was used, the cut-off being varied from three-quarters to one-quarter stroke respectively, and from about 38 deg. to 50 deg. Cent. lower when the engine was using superheated steam over the same range of cut-off. Still earlier cut-off caused still larger temperature differences, whilst jacketing naturally reduced these values appreciably. The temperature measurements were made in holes at points along the cylinder wall, which were bored to within different distances, down to 1·5 mm., from the inner wall. These holes were filled with mercury into which thin mercury thermometers were inserted. From these tests it was established that the differences of temperature between steam and wall are, in each case, much larger than had been assumed by Fliegner in his calculations of the coefficient of heat transfer, and that therefore the coefficient is appreciably smaller than he stated.

The lecturer pointed out the remarkable fact, computed from the test data of Donkin, that the mean temperature of the wall during a cycle is always appreciably higher than the mean temperature of the steam, even although the engine is not jacketed. Further, that the average temperature of the wall becomes higher with a later cut-off.

In the year 1897-8, in the "Proceedings" of the Institution of Civil Engineers, appeared the classical paper of Professor Callendar and the late Professor Nicolson, "On the Law of Condensation of Steam Deduced from Measurements of Temperature Cycles of the Walls and Steam in the Cylinder of a Steam Engine." These two workers undertook, for the first time, the measurement of the range of temperature of the working steam end of the inside of the cylinder wall during a cycle. They employed a platinum resistance pyrometer with a wire 0·025 mm. diameter, to measure the steam temperature; for the instantaneous wall temperatures they used thermo-couples of which one element was the wall itself. In this way an important source of error was eliminated, viz., the necessity of transmitting heat from the wall to a separately built-in thermo-couple, which would render impossible the measurement of the instantaneous temperatures. On the assumption that the work of Callendar and Nicolson is well known in this country, Professor Nägel did not describe in detail their methods of measurement and their results. He confined himself to those matters that are of importance in relation to his later lectures.

For determining the instantaneous value of the electromotive force Callendar and Nicolson used the compensation method of Poggendorf. A switch was inserted into the galvanometer circuit, whose time interval of contact could be varied and which permitted contact to begin at any desired crank angle, *i.e.*, at any desired point in the piston stroke. The normal duration of contact was one-thirtieth of one revolution. The thermo-couples, of which eight were arranged in a circle in the cylinder cover and eighteen arranged at points along the cylinder wall, were inserted to different depths from the outside wall. The deepest were about 0·25 mm. distant from the inner wall. The platinum thermometer for measuring the steam temperature was fastened to the middle of the top of the piston and projected about 75 mm. into the steam space, a corresponding recess being provided in the cylinder cover. In the first tests the pyrometer was secured to the middle of the cover without projecting into the steam space. The mean temperature found in this way is actually greater than the temperature of the steam as determined from the indicator card. The lecturer next showed a diagram which demonstrated the good agreement in the temperatures found from an indicator card and those from the pyrometer fixed in its final position, *i.e.*, projecting into the steam space.

Fig. 1 shows one of the diagrams, given by Callendar and Nicolson, which the lecturer used to explain some of their conclusions. The temperatures of the walls of the cylinder cover and of the side walls near the head at a depth of 1·0 mm. are shown by the two broken lines; the full line shows the temperatures of the steam as obtained from an indicator diagram. The shaded area corresponds to that part of the curve


STEAM TEMPERATURE—DEGREES FAH.
TIME IN SIXTIETHS OF A REVOLUTION FROM BACK END OF STROKE
Speed, 43·9 revolutions per minute.

METAL CYCLES $\frac{1}{16}$ INCH IN COVER AND NO. 1 SIDE.
"THE ENGINEER"

FIG. 1

of steam temperature within which the temperature of the wall is lower than that of the steam. The curves have time as abscissa and temperature as ordinate. The area to which Callendar and Nicolson refer as the "area of condensation" and denote by "A," is time (secs.) × deg. Fah.

Taking into account the physical properties of the cast iron of which the cylinder was made, *i.e.*, its density, specific heat, and thermal conductivity, they calculated the quantity of heat per unit of area which, at a certain engine speed, enters or leaves the wall during a cycle, the temperature range at a depth of 1·0 mm. showing a maximum variation of a certain value. They showed mathematically that the geometrical characteristics of the fluctuations given by the temperature curve may be very different without appreciably modifying the quantity of heat interchanged with the wall. This led them to place in direct proportion, the other conditions being unaltered, the quantity of heat interchanged, with the maximum fluctuation of temperature as determined from the wall temperatures.

Callendar and Nicolson confined themselves to determining that heat quantity per square foot delivered from the steam to the wall during the "area of condensation" which is approximately the admission period. This heat quantity they denoted by "Q." Then the fraction $\frac{Q}{A}$ is the coefficient of heat transfer. This they found to be nearly independent of the speed and point of cut-off of the engine when using saturated steam. Its value was found to be 0·61 B.Th.U. per deg. Fah. per square foot per second, which, expressed in K. cal. per deg. Cent. per square metre per hour gives the value $\alpha = 10{,}700$.

They made some suggestions and calculations of especial interest concerning the equilibrium of the expanding steam. Let saturated steam 1·0 per cent. wet be considered expanding adiabatically from, say, about 115 lb. per square inch to about 85 lb. per square inch. The moisture content would increase to about 3·0 per cent. At the same time the temperature will fall by about 11·5 deg. Cent. It may be imagined that the increase of moisture content is caused by the condensation of the steam on the surface of the water drops already in suspension in the steam. Then the latent heat of the steam particles being condensed is transferred by means of the drops to the surrounding steam. At the same time the water drops share in the decrease of temperature corresponding to the diminished pressure. Thus they must also deliver heat to the surrounding steam, which causes evaporation at their surface. This process is only possible when the condensed steam is at a lower temperature than the existing water drops. The temperature difference therefore required is directly proportional to the speed of the engine and also—since the exchange of heat depends upon the area of the surface—to the diameter of the drops. Further, the temperature difference will decrease as the quantity of the existing moisture increases.

At the beginning of this adiabatic expansion the increase of moisture content of 1 kilo. of steam should be about 1·74 grammes for a drop in temperature of 1·0 deg. Cent., and the latent heat which must be liberated should amount to about 0·86 K. cal. To this should be added the heat content of the original water drops, which weigh 0·01 kilo., giving the heat available on a fall of 1·0 deg. Cent. as 0·01 K. cal. So that the total heat to be transfered from the water drops is 0·87 K. cal. The influence of the sensible heat of the liquid is always small and is never relatively important when compared with the latent heat of the newly formed condensate. If this expansion took place at $^1/_2$ stroke the movement of the piston for a drop in temperature of 1·0 deg. Cent. is from 0·2 to 0.2059 stroke, or 50 min. of crank angle. This at n r.p.m. means a time interval of $\frac{5}{36n}$ seconds, which at $n = 100$ is 0·0014 seconds and at n 500 is 0·00028 seconds.

Little is known at present concerning the diameter of the water drops formed as moisture content in steam by adiabatic expansion. Professor Nägel expressed the hope that the tests now being undertaken by several workers, to investigate the atomising process of fuel in Diesel engines may shed light on this analogous problem. Callendar and Nicolson computed 0·0006 mm. as the diameter of the water drops. If this be accepted, then 1·0 per cent. of moisture in 1·0 kilo. of steam should contain $8{\cdot}84 \times 10^{13}$ drops with a surface of 100 square metres. Using in the calculation the value of the coefficient of heat transfer recently determined by Professor Nusselt, of Munich, $\alpha = 50{,}000$ K. cal. per deg. Cent. per square metre per hour, the fall of temperature should be only 0·45 deg. Cent. at 100 r.p.m. and 2·2 deg. Cent. at 300 r.p.m.

In spite of the fact that these phenomena, which were investigated originally by Callendar and Nicolson, can scarcely have any immediate practical importance, Professor Nägel held that they give an interesting view into the mechanism of condensation and may also disclose facts concerning heat transmission that may be of future importance. The investigations of these two workers constitute the first successful attempts at indicating the temperature ranges in steam engines, and are therefore worthy of being prominently discussed in connection with his, the lecturer's, subject.

(To be continued.)

LUBRICATION.—At the opening meeting of the session of the Junior Institution of Engineers, on Friday, October 7th, Professor Edwin Edser gave a lecture on the subject of "Lubrication." Professor Edser confined his remarks in the main to the scientific principles of lubrication, and conducted one or two simple experiments to illustrate his points. He emphasised that lubrication did not depend only on viscosity; it was necessary for the lubricant to be attracted by the material to be lubricated to such an extent that it was carried into narrow spaces to form a separating film. He illustrated the way in which a shaft will wear its bearing to an elliptical shape in order that the lubricant can be forced into wedge-shape spaces, thus causing the requisite pressure to be generated for maintaining the lubricating film. It would follow that the sooner that a bearing reached this condition the better it would be. It had been found that in running in a machine the desired condition of affairs could be reached much more quickly by using a vegetable oil, which had a slightly corrosive action.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—The following courses of lectures have been arranged to be delivered at the Royal Institution during November and December next:—On Tuesdays, November 1st, 8th, 15th, at 5.15 p.m., three lectures on "Light and Sight" (the Tyndall Lectures), by Sir John Herbert Parsons, F.R.S.; on Tuesdays, November 22nd, 29th, December 6th, 13th, at 5.15 p.m., four lectures on "A Year's Work in X-ray Crystal Analysis," by Sir William Bragg, F.R.S. (Fullerian Professor of Chemistry); on Thursdays, November 3rd, 10th, at 5.15 p.m., two lectures on "The Furniture and Equipment of the Mediæval House," by Mr. H. Clifford Smith, Assistant Keeper, Victoria and Albert Museum; on Thursdays, November 17th, 24th, December 1st, at 5.15 p.m., three lectures on "London Before the Norman Conquest," by Dr. R. E. Mortimer Wheeler (Keeper and Secretary of the London Museum); on Thursdays, December 8th, 15th, at 5.15 p.m., two lectures on "Petroleum Natural Gases and their Derivatives," by Mr. James Kewley, M.A., F.I.C., M.I. Chem. E., M.R.I.; on Saturdays, November 5th, 12th, at 3 p.m., two lectures on "The Main Features of Modern English Literature," by Monsieur Emile Cammaerts; on Saturdays, November 19th, 26th, December 3rd, at 3 p.m., three lectures on "Samuel Wesley and Robert Pearsall," by Mr. Gustav Holst; and on Saturdays, December 10th, 17th, at 3 p.m., two lectures on "Recent Developments in Astrophysics," by Mr. F. J. M. Stratton, M.A., D.S.O., D.L. The one hundredth and second course of Christmas lectures adapted to a juvenile auditory will be delivered by Dr. Edward N. Da C. Andrade on "Engines: (I.) The Rules which all Engines Must Obey; (II.) Learning about Steam; (III.) Engines which Work To and Fro; (IV.) Engines which Work Round and Round; (V.) Putting the Furnace in the Cylinder; (VI.) Heat Engines which Produce Cold." The lectures will be on Thursday, December 29th, Saturday, December 31st, Tuesday, January 3rd, Thursday, January 5th, Saturday, January 7th, and Tuesday, January 10th, at 3 p.m. on each occasion.

The Plastic Deformation and Fracture of Metals.*

By WALTER ROSENHAIN, D.Sc., F.R.S., of the National Physical Laboratory, Teddington, England.

The behaviour of metals under strain and the manner in which they undergo plastic deformation and fracture is a matter of interest and importance both to engineers and metallurgists, and it seems worth while to summarise the position of the various problems relating to plastic strain and fracture as they stand to-day.

It is proposed, as the basis of discussion, to regard as established that plastic deformation in metals normally occurs by a process of slip within the crystals, and that in most metals this slip occurs on certain definite crystallographic planes. If we begin by confining our attention to a single crystal, the question arises whether any system of slipping within such a crystal, if unaccompanied by any other internal change in the structure of the crystal, can give rise to an increase of hardness. If it can, the problem then arises, What is the nature of the internal change accompanying the process of slip which causes the effective hardening of the crystal? Perhaps the simplest theory is that known as the "exhaustion" theory. From the fact that visible slip surfaces are formed, it follows that slip must take place more readily on certain surfaces within the crystal than on other surfaces parallel to them. Were all parallel planes alike in regard to the facility for slip under the requisite stress, slip should occur simultaneously on all of them, and the result would be a homogeneous shearing of the crystal rather than a discontinuous step-like deformation. But once those planes have undergone slipping, those "most favoured" planes will have been used, and, it is suggested, further deformation can only occur if the stress is increased sufficiently to bring about slip on other less "favoured" planes. As deformation proceeds, therefore, planes having greater and greater resistance to slip will come into play, requiring increased stress.

That some such action really occurs is very probable, but this fact does not really explain the basic phenomenon, because it assumes that, once slip has occurred on a given surface, the resistance to further slip on that surface will be greater than it was originally, *i.e.*, it supposes that hardening has occurred on the "used" slip planes, so that further slip must occur elsewhere.

The view which is perhaps most widely held at the present time is that the hardening of a crystal under progressive deformation is due to a "straining" of the lattice. At first sight this appears a very satisfactory explanation. But before it can be accepted as anything more than a vague generality, it is necessary to consider how much deformation a lattice can undergo without breaking down, and also in what manner the strain imposed upon a lattice by the application of a stress due to external forces can be retained permanently by that lattice after the external forces have ceased to act.

The really fundamental question is whether such permanent change of shape is due to a permanent—or plastic—distortion of the lattice. The answer is, in the writer's opinion, definitely in the negative. A great many measurements of plastically deformed metal by means of X-rays have been made, and these indicate a number of striking and interesting phenomena, but a definite permanent change of lattice parameter has not been observed. The X-ray spectrum of such a structure would show not only displacements of the lines originally given by the crystal or a slight blurring or diffusion of those lines, but entirely new series of lines due to the lowered symmetry of the deformed lattice. It is suggested therefore that existing experimental evidence definitely disproves the possibility of any considerable plastic deformation of the lattice of the crystals of ductile metals. When, therefore, we speak of lattice distortion, it must be borne in mind that the distortion of any individual lattice unit must be small, and that therefore the distortion will be of an almost completely elastic nature—*i.e.*, it will tend to disappear as soon as the distorting force ceases to act, unless something has occurred in the vicinity to prevent a return to the normal configuration. In this last sentence lies the key to the view of the whole of the phenomena of plastic deformation which the writer regards as the most satisfactory now available.

In considering what can occur in a crystal lattice which undergoes a permanent—*i.e.*, an elastically non-reversible—change, the first question that arises is, What will be the consequence of a "break down" of the lattice? It seems that the only conception of such breakdown is rupture of an inter-atomic bond, which may be regarded as constituting local fracture. It may, however, also be regarded in another way. The difference between the solid and liquid phases consists mainly in the fact that in the liquid state there are fewer and less permanent attachments between adjacent atoms or groups of atoms (molecules). The rupture of any set of inter-atomic bonds, therefore, especially if it does not involve mass separation, may also be regarded as being equivalent to local melting.

But the conception which the author desires to suggest is that where breakdown of a lattice has occurred we may expect to find—if or when our means of observation become sufficiently refined—a region in which the lattice structure only persists in a fragmentary form, the various fragments being held together by inter-atomic linkages of a more or less random nature—*i.e.*, where atoms have formed cohesion bonds not in accordance with the regular lattice system, but in an irregular manner, wherever their juxtaposition within the range of inter-atomic cohesion has made such a bond possible.

These considerations of the nature of the disturbed region which is likely to be formed where slip has occurred in a lattice, have hitherto led the present writer to adopt the view first put forward by Beilby, according to which these disturbed or "amorphous" layers were themselves the cause of the hardening of metal by cold work. But the severest cold working falls far short of destroying the crystal structure, and no method is known of producing amorphous metal in considerable quantities. The inference is therefore suggested that the hardening effect of the disturbed or amorphous layers is not directly due to their own hardness, but is of an indirect nature†—*i.e.*, these disturbed regions serve to restrain the return of the elastically distorted portions of the lattice to their normal configuration, and thus maintain the crystal lattice of cold-worked metal in a slightly distorted condition.

It is not difficult to see, in general terms, that the formation of a disturbed layer between adjacent sections of a crystal lattice would act in such a manner as to prevent the return of those sections of lattice to their normal configuration. In the disturbed layer itself, such a return would not be possible, and, since the edges of the undisturbed lattice are necessarily firmly attached, atom by atom, to some of the atoms of the disturbed layer, an anchorage is provided for retaining the lattice sections in their elastically distorted state. The result must be a state of internal strain, stresses of opposite sign being retained in the distorted lattice and the disturbed layers respectively. We can, however, carry the picture considerably further.

The present writer has developed elsewhere a theory of the effects of lattice distortion, *i.e.*, of distortion within the limits set by the range of cohesive attachment between adjacent atoms.‡ The fundamental consideration is that where an atom is situated on the point of a lattice well within a crystal it is subjected to a completely balanced set of forces derived from the mutual attractive and repulsive forces exerted upon it by its neighbours. Where one of these neighbours is an atom of a different kind, exerting slightly different forces, the adjacent atoms must be pushed or pulled slightly out of their normal symmetrical positions in order to attain equilibrium and a distortion of the lattice, which may be either mainly local or mainly general, will result. But if, instead of having as one of its neighbours a stranger atom exerting slightly different forces, an atom situated on a lattice finds itself either with no neighbour at all within reach on one side, or in relation with an atom placed in some irregular position, a still more marked distortion of the lattice must result.

The writer considers that probably the hardening of metals by cold working arises chiefly from this source of lattice distortion rather than from any general straining of the lattice in relatively large regions or sections. This is suggested by two independent facts. The first is that, even when metal has been strained far beyond the elastic limit, when the stress is released, there is an immediate elastic contraction.

The second fact is the progressive increase of hardness of metal with increasing cold working. On the view here suggested, every surface of slip becomes the site of a layer of disturbed material in which the regular arrangement of the atoms is more or less completely broken down, and the existence of this disturbed layer must produce a certain degree of distortion of the adjacent portions of the lattice. But such distortion can only extend inward into the lattice to a certain depth, which is probably quite small when compared with the distance between adjacent slipbands, although a large number of layers of atoms may be affected. Now, in the early stages of plastic deformation the slip-bands are relatively very far apart, and we should thus expect to find that there are large regions of the lattice still unaffected by any distortion. In these, slip will occur with little more resistance than it did on the surfaces of initial slip, although the existence of slip-planes in several directions in space must to some extent affect the resistance to slip even in the least affected portions of the lattice. After slight plastic deformation, therefore, we have conditions that explain only a slight increase of hardness. With every further occurrence of slip, however, the width of the layers of lattice between adjacent slip-bands diminishes rapidly and the hardening effect of the local lattice distortions emanating from each surface where slip has occurred will progressively affect a larger and larger proportion of the whole lattice, thus accounting for a progressive increase of hardness. It is, of course, possible that both general elastic deformation of the lattice as well as local distortion emanating from the surfaces where slip has occurred may play a part in the production of work-hardness, and the relative importance of these parts may be widely different in different metals, their behaviour depending to a great extent on the relative rigidity of the lattice.

Briefly summarising what has been said above, the view is put forward that:

(1) The occurrence of slip within a crystal must be accompanied by internal changes in the crystal which produce increased resistance to further slip. This resistance is sufficient to arrest slip that has already started and to require a higher stress before fresh slip can be started on other slip surfaces.

(2) Plastic deformation of the lattice without breakdown being excluded, it is suggested that purely elastic deformation of the lattice could not be retained in a single crystal and that some disturbance of the lattice structure at and near the surfaces of slip is probable.

(3) The formation of a disturbed layer in which the atoms are no longer regularly arranged on a lattice will produce the requisite resistance to further slip on the original surface by the local destruction of the regular atomic planes on which slip takes place, and that the distortion of the adjacent lattice, due to incompletely symmetrical balance of inter-atomic forces, will produce a local distortion of the adjacent lattice which increases resistance to slip in adjacent slip planes.

This view, it will be seen, constitutes a distinct modification of the view of Beilby hitherto accepted by the present writer. According to that view the strain-hardening of a crystal was ascribed to the intrinsic strength and hardness (non-ductility) of the amorphous layers formed on surfaces of slip. According to the present view, the effect of the local disturbance of the crystal structure is mainly indirect—in distorting the adjacent portions of the lattice. On this view it is not necessary to suppose that the disturbed layer is more than a few atoms thick.

Among the most interesting phenomena which accompany plastic strain are those connected with what is sometimes known as the "semi-plastic" state of wrought iron and mild steel. The facts may be briefly recalled by saying that immediately after a tensile test piece of steel has been strained beyond the yield point, it ceases to display the normal elastic behaviour under low loads, the stress-strain graph being curved almost from zero load, while at least part of the extension which occurs along this curved graph is permanent, *i.e.*, does not disappear when the load is removed. This state is, however, a temporary one and disappears after a time even at room temperature, the time required for "recovery" varying from a few hours to several days according to the composition of the steel. The recovery is, however, very much accelerated by raising the temperature; even at 100 deg. Cent. recovery occurs in less than half-an-hour and it is still more rapid at 200 deg. Cent. This semi-plastic condition is definitely known only in wrought iron and steel, but has never been observed even in the hardened non-ferrous metals. So far as the writer is aware, it does not occur in copper or the alloys of copper. For this there may be a simple explanation; for instance, the phenomena of the semi-plastic state may occur with great rapidity so that, by the time that an extensometer test can be made, full "recovery" has occurred. On the other hand, the phenomenon may be peculiar to metals following the body-centred cubic lattice system of crystallisation, since it is known that their mode of deformation by slip differs in detail from that followed by face-centred cubic and hexagonal lattices. There is also another factor which may enter into the matter, viz., the relation of room temperature, at which such experiments are usually conducted, to the melting point or so-called "equivalent temperature" of the metal. In this respect most of the non-ferrous alloys differ widely from iron and steel. If the two last-named factors are important, we should expect to find similar phenomena in tungsten when tested with an extensometer at a temperature where it can undergo both elastic and plastic deformation, *i.e.*, in the neighbourhood of 1500 deg. Cent. There are, however, serious experimental difficulties in the way of verifying this possibility. Finally, the allotropic transformability of iron must be considered as a possible factor in its behaviour under strain.

In view of the apparantly contradictory facts and the possible complexity of the phenomena, it is impossible at the moment to suggest any entirely satisfactory theory for the mechanism by which the semi-plastic state is produced. None the less, the view put forward above concerning the formation of "disturbed" or amorphous layers on slip surfaces does afford some measure of explanation of the phenomena. In Beilby's original "amorphous" theory, the amorphous material when first formed possessed a considerable degree of temporary mobility. By this mobility it was believed that it could flow over a surface during polishing, for example, and the evidence proving the occurrence of such flow on polished surfaces, is so strong that it lends much weight to the idea. According to the somewhat modified view now put forward, however, we are able to form a more definite picture of what is likely to occur in the formation and subsequent behaviour of "disturbed" or "amorphous" layers on slip surfaces. Reference has already been made to the writer's analysis of the inner structure of truly amorphous substances§, which may be regarded as entirely heterogeneous assemblages of atoms. The disturbed layers on slip surfaces are not likely to be so completely amorphous—*i.e.*, considerable remnants of the lattice structure probably persist, joined by atoms irregularly linked together. Even here, however, once the lattice has begun to break down, there will be present, statistically, pairs of atoms linked together across distances ranging from the minimum to the maximum at which inter-atomic bonding can occur, while in a certain number of cases, pairs of atoms, with "unsatisfied" bonds will be juxtaposed, but at distances apart too great to allow of bonding to occur. When the operating stress is removed, a certain amount of immediate rearrangement must occur, owing to the relative movement of the atoms due to elastic recovery, and this is likely to cause existing inter-atomic bonds to break here and there, while in other cases atoms previously too far apart may be brought within cohesion range of each other. All that is essential to the present conception is that at this stage there must be considerable numbers of possible atomic linkages which are not effective. It is suggested that this factor is responsible for the apparent "temporary mobility" of the disturbed or amorphous material.

The further stages of the phenomenon may well depend upon the state of thermal agitation of the metal. If the metal is at a temperature relatively high in reference to the melting point, the amplitude of thermal oscillation will be large and therefore pairs of atoms placed at distances apart not far beyond the range of possible linkage will be brought within that range during a relatively short time. At lower temperatures this will occur only in the course of a much longer time, but in either case there must be a strong tendency—for thermodynamic reasons—for the formation of every possible linkage that can be effected by slight thermal shuffling of the irregularly arranged atoms, since the formation of additional linkages lowers the potential energy of the system. The "temporary mobility" of the disturbed layers must therefore tend to decrease, slowly at relatively low temperatures and increasingly quickly at higher temperatures.

An interesting question arises in connection with the state of temporary "semi-plasticity" in steel in relation to its bearing on the behaviour of steel under alternating stresses (fatigue). Under "fatigue" conditions, whether in service or under test, alternations and repetitions of stress occur so rapidly that, so far as lapse of time is concerned, there can be no question of recovery, even if there is an appreciable rise of temperature. At first sight, this fact might be supposed to afford the explanation of fatigue failure. But if the semi-plastic state really played an important part in fatigue phenomena the introduction of periods of rest and "recovery" in the course of a fatigue test should make a great difference to the results. There is no evidence that this is the case, the experiments tried to investigate the point having always shown that intermediate periods of rest do not affect the result of a fatigue test. An explanation, however, suggests itself. After uni-directional strain, recovery in iron is slow at

* Address to the International Congress for Testing Materials at Amsterdam. Greatly abridged.

† F. C. Thompson has raised this difficulty, and suggested that the effect of the amorphous layers is due to "surface tension" between the amorphous layer and the crystalline portion.

‡ Rosenhain, "The Inner Structure of Alloys," *Journ.*, Inst. Metals, Vol. 30, 1923; *Journ.*, Roy. Soc. Arts, October 9th, 16th, 23rd, 1925.

§ Rosenhain, 'The Structure and Constitution of Glass," *Trans.*, Soc. Glass Tech., 1927, Vol. 11.

room temperature, but considerably accelerated by thermal agitation of the atoms. Under the conditions of a fatigue test, however, there is also an agitation of the atoms, partly of a purely elastic nature, and partly due to the introduction of fresh lattice distortions by the formation of disturbed layers on successive slip surfaces. This atomic agitation, whose amplitude is of an order not very different from that caused by rise of temperature, may well supply the place of heating and facilitate the "setting" of the disturbed layers. If this is the case the semi-plastic state would not arise under fatigue conditions, and the small effect of periods of rest would be explained.

Before passing to a consideration of the general problem as it affects crystal aggregates as distinct from single crystals, the mechanism of fracture itself requires consideration. The first point of attack that presents itself is that so long as slip is possible, fracture will not occur. This is simply another way of saying that before fracture can take place, ductility must be, locally at least, exhausted. In cases where there is reduction of area before fracture, it is obvious that the bulk of the test piece may retain considerable ductility while locally, at the point where fracture occurs, the ductility has been exhausted by sufficiently close juxtaposition of slip surfaces and the resulting disturbed layers. The way in which fracture occurs can perhaps be best illustrated by an analogy taken from textile fabrics. A loosely woven fabric is difficult to tear or rip, because when the stress on any one fibre becomes severe, that fibre stretches and allows the load to fall upon the next, and so on until the load is borne by a large number of fibres. If, however, the fabric is very tightly woven or, more markedly still, if it is treated with a dressing which, while it strengthens the individual fibres, causes them to adhere to one another at their crossing points, then the fabric tears very easily. The reason is clearly that the outside fibre, when the load is applied, is too firmly held by the transverse fibres to allow it to stretch and share the load with adjacent fibres, with the result that the stress becomes concentrated on successive outer fibres in turn, and these fail one after the other. The limiting case of a material of this kind is a continuous sheet, which may be regarded as consisting of an infinite number of fibres quite unable to move relatively to one another if the material of the sheet is non-ductile. For this reason, a thin sheet of high-tensile steel, if hard and non-ductile, can be torn with the fingers in spite of its high strength, while a sheet of copper of the same thickness is very difficult to tear in this way. In a metal, while "fibres" need only be thought of in a geometrical sense, so long as there is any ductility, an overstressed fibre will yield and share its load with its neighbours, much as in the loosely-woven fabric. When this can no longer occur, the stress on a particular fibre may reach the full cohesive strength of the material while the average stress is still far lower. Then tearing will commence and bring about the rupture of the whole piece.

In the present discussion, up to this point, attention has been confined to a consideration of what occurs during plastic strain in a single crystal. Both for theoretical and practical purposes, however, it now becomes necessary to consider the more normal type of metal, *i.e.*, the crystal aggregate.

If a strip of an approximately pure metal is polished and is then subjected to slight plastic strain, one of the first effects is the "development" of the crystal boundaries—beside the formation of a few fine slip-bands the crystal boundaries become visible as dark lines or zones when seen under "vertical" illumination. Examination shows that there has been a minute amount of relative movement among the crystals at their boundaries, and on the originally smooth surface these are seen as dark lines or zones, because slight differences of level have been developed. That, when a crystal undergoes even a slight change of shape, there must be some movement at its boundaries is obvious, but recent research has shown that there is more movement than that merely due to the change of external contour of the individual crystal. Starting with metal in which the orientation of the crystals is random, after sufficiently severe cold-working we find that the crystals of the material exhibit a strong tendency towards a particular orientation. If the crystals of an aggregate were mere smooth rounded lumps embedded in a mobile matrix, rotation in response to external applied stress would be readily understood. Even if the crystals of an aggregate were geometrical shapes packed together with smooth, close-fitting outlines, relative movement could be readily conceived. In fact, however, the crystal grains of metals have irregular outlines which are only rarely smooth in detail, so that relative motion must be very difficult and can only occur by the partial local breakdown of the crystal structure itself in the vicinity of the boundary. Before we can hope to understand the conditions of the problem of inter-crystalline movement at the crystal boundaries it is necessary to form some conception of the nature of those boundaries and of the manner in which adjacent crystals are attached to one another.

The present writer, some fifteen years ago, put forward what has come to be known as the "amorphous intercrystalline cement" theory on the intercrystalline boundary. Like other views previously held in regard to the structure and behaviour of metals, that theory has necessarily been affected by modern advances in knowledge derived both from the study of single crystals and X-ray spectra. If, however, we accept the fundamental principle that there is a definite and low limit to the possible elastic deformation of a crystal lattice and that, accordingly, a crystal lattice cannot be bent, so as to assume more than a curvature of very large radius, it can be shown that the transition from one crystal lattice to another in a metallic aggregate must involve the presence of a layer of irregularly arranged atoms, possibly not more than from ten to a hundred atoms thick, by means of which this transition is accomplished.

In the writer's opinion, the evidence seems to show conclusively that intercrystalline boundaries, at temperatures well below the melting point of the metal, are regions of greater cohesion than exists within the body of the adjacent crystals, and this state of affairs cannot be accounted for merely by supposing that there are common atoms here and there, depending upon the haphazard manner in which two adjacent lattices come into contact. If, however, we reject the idea that the few possible common atoms constitute a sufficient cohesive connection between adjacent crystals, we must admit the existence of a transitional structure between adjacent lattices and, in a sense, bridging the difference or orientation between them. There appear to be only two possible structures which such a transitional region could assume. One of these may be described as the "bent lattice" structure, while the second implies an irregular or "amorphous" distribution of the atoms. The "bent lattice" structure implies a configuration in which the orientation of the two adjacent lattices is brought into gradual approximation, from cell to cell, by distortion of the cell, which may imply both bending and twisting, until they are brought into conformity. The difficulty here arises that the amount by which each cell of the lattice can be distorted is very small and that consequently the radius of curvature of this "bent lattice" structure must be large. It follows that the transition zone between one crystal and another would be very wide and that its width would vary appreciably according to the relative angles at which the lattice lines of the two crystals met each other. If these ideas are worked out in detail, assuming for the maximum possible lattice distortion the amount of distortion which occurs under elastic stress before the lattice begins to break down by the occurrence of slip, the result arrived at is that the width of the transition zone would be comparable with that of the crystals themselves in the finer kinds of aggregates with which we are familiar in metals. Since it is well known that the actual boundaries themselves are very narrow indeed compared with the size of even the smallest crystals, this "bent lattice" structure appears to be impossible.

The only alternative method by which adjacent lattices, at a random angle to one another, can be connected is by a layer of irregularly arranged atoms. In such a layer the atoms would be arranged subject to the same laws governing interatomic cohesion which hold within the lattice structure itself, but with this difference:—Whereas in the regular, undistorted lattice the inter-atomic distances and angles are regular and symmetrical, giving a lattice parameter which is only very slightly departed from as we pass from one region of the lattice to another, in the irregularly arranged layers the atoms will be found to lie at all manner of distances, varying from the minimum to the maximum across which inter-atomic cohesion can occur, while there will be many instances where adjacent atoms are too far apart to be physically interconnected at all. This is a structure strictly analogous to that which has been ascribed to such a substance as glass, although its mode of origin may be very different. It will, however, have certain properties in regard to visco-elastic behaviour at temperatures far below the softening point, and truly viscous behaviour at higher temperatures similar to those of glass. In chemical properties, in fact, such an irregular layer of atoms will exactly correspond with the disturbed layer formed, as we have suggested above, on surfaces of slip.

The above brief exposition of the amorphous theory has only been given for the purpose of illustrating the kind of picture which can be formed of the state of a metal at a crystal boundary. The formation of some such picture appears to the writer to be essential in order to form concrete ideas as to what occurs when a crystalline aggregate undergoes plastic deformation. As the intercrystalline boundaries are irregular surfaces, neither geometrical in general outline nor smooth in detail, the occurrence of any simple kind of sliding motion at interfaces does not appear to be possible. Since relative displacement of the crystals is known to occur and, indeed, under severe deformation to occur to a very large extent, it is obvious that important changes must take place at and near the crystal boundaries during the process of plastic deformation.

X-ray evidence has shown conclusively that, in cold-worked metal, the crystals tend to assume a definite orientation and this can only be accounted for by a rotation of the axes within the grain or by the bodily rotation of the grain as a whole. The former is regarded as extremely unlikely, since it would involve changes as profound as recrystallisation. Bodily rotation, however, implies profound changes near the crystal boundaries, and the formation of disturbed or more or less "amorphous" regions of much greater depth than those likely to be formed on slip surfaces. This accounts for the greater degree of work-hardening in poly-crystalline metal as compared with single crystals and also for the larger changes in density. If rotation occurs during cold work, the bodies that rotate must be more or less cylindrical in shape and the micro-structure of cold-drawn wire is that of a bundle of more or less cylindrical fibres. Further, the hardening effect of the disturbed material near the original crystal boundaries will consist mainly in resulting distortion of the adjacent crystal lattices; one would therefore expect a finely-crystalline material to harden more rapidly under the first application of cold-work than one having coarser crystals.

Within the limits of space and time available it is not possible to carry much further this discussion of the mechanism of deformation and rupture in crystalline metals. Neither is it possible in the existing state of our knowledge to put forward a complete and satisfactory theory covering the whole of the phenomena. The object of the present discussion, however, has been to show how far the new facts brought out by recent research fit into the older theoretical views and also to call attention to some facts and considerations which many recent workers in this field appear to have ignored. The mechanism of relative rotation of irregularly shaped crystals is one of these, and the relation between slip-bands and Neumann lines is another. Such theoretical suggestions as have been put forward here have been presented not so much in the hope that they may prove to be the finally correct representation of the facts, as for the purpose of furnishing a working picture of what may be happening among the atoms of metal under strain. However crude and imperfect such a picture may be, it yet serves to focus ideas upon the mechanism involved and makes it easier to co-ordinate the new facts which come to light day by day. Ultimately it may be hoped that crude and imperfect pictures may develop into a complete and orderly theory of the whole of the complex phenomena involved. And such a theory is no purely academic ideal. It would furnish us with the knowledge needed for the production of better materials of construction and for the better utilisation of known materials. At present we test our metals by comparatively crude empirical methods; it will only be when we know exactly what are the properties which are of importance in resisting deformation and fracture that we shall be able to devise rational and scientific tests. Every step we can take in the direction of a fuller understanding of the internal mechanism of metals is, therefore, a step forward in the testing and use of metals as engineering materials.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RECENT BRITISH LOCOMOTIVES.

SIR,—Mr. H. N. Gresley, Chief Mechanical Engineer of the L.N.E. Ry., in his presidential address to the Institution of Locomotive Engineers, September 29th, 1927, said:—"The thermal efficiency of the modern locomotive is deplorably low." In the opening address to the Institution of Mechanical Engineers, N.W. Division, the President, as reported in THE ENGINEER, said:—"The thermal efficiency of locomotives to-day is little superior to that of the locomotives in the days of Stephenson."

With high pressures up to 250 lb., superheated steam, with long maximum valve travels (equivalent, in effect, to trip gears with poppets or slides), with limited maximum cut-offs, and abnormally large total cylinder volumes for live steam; with feed heaters and sometimes with boosters, THE ENGINEER has reported, during the last three years, maximum efficiencies of up to 8·22 per cent. indicated in the cylinders. In America 7·5 per cent. and 8 per cent. have been chronicled as the best road results in indicated thermal efficiencies, and the highest values, deducting losses, of the same tests have also been reprinted in THE ENGINEER. Nothing higher than this is now to be expected, according to American experts, as quoted recently by English railway journals.

During the years 1892 to 1906 THE ENGINEER, in documented articles, reported efficiencies corresponding to 8·8 per cent., with saturated steam at about 160 lb. boiler pressure, in very ordinary types of compound locomotives. The authorities have been so often given with these references in THE ENGINEER since 1896 that, at this time, there is no need for their repetition. THE ENGINEER back volumes are always open for references, but as one example at least might be mentioned, the case of Hornblower-Woolf compound locomotives at 160 lb. boiler pressure, using saturated steam and consuming only 8·7 kilos. = 19·1 lb. per I.H.P. hour, and 0·96 kilos. = 2·01 lb. coal per I.H.P. hour, each pound of coal evaporating 9·04 lb. water ("Rapport de la Commission sur l'Essai de Locomotive Tandem Compound," Inst. C.E., Paris, 1892).

At the World Power Conference, 1925, Mr. C. B. Collett, Chief Mechanical Engineer of the G.W. Ry., gave a paper with the figures of tests made on the route Swindon–Plymouth–Swindon with the "Castle" class locomotive, showing that, with each pound of coal evaporating 12·2 lb. water, the coal consumption was 2·1 lb. per I.H.P. hour, and the net steam consumption, after deducting various losses, 20·9 lb., the thermal efficiency, indicated, being 8·22 per cent.—results which have established the G.W. Ry. high-pressure locomotives as the most efficient of single-expansion locomotives in England.

THE ENGINEER showed on page 509, June 8th, 1917, that, in much more severe service and wholly on up-grade lines—82 miles uphill—the "simple" consumptions may be yet lower than those recorded by Mr. Collett, even with lower boiler pressures, if only the simple engines are operated with partially closed throttles, in reducing the initial cylinder pressures, but in cutting off the steam at 42 per cent. to 48 per cent. of the stroke. To urge this improvement and thermal efficiency increase in writing is so much waste of time. It proved, indeed, useless for Mr. Ivatt to recommend it at the Institution of Mechanical Engineers twenty years ago. On the Continent it required strict injunctions to the enginemen and constant supervising on the footplate by foremen drivers to convince the men of the steam and fuel waste by the use of 20 per cent. to 30 per cent. cut-offs, as then practised alike in compound and simple locomotives. However, in Italy, by means of 35 per cent. to 45 per cent. cut-offs, this was demonstrated in 1907–9 on an extensive scale, and also that all tractive effort modifications could be obtained when at full speed simply by means of the regulator alone; and it was thus that the very low "simple" consumptions, of down to 19 lb. per I.H.P. hour, were realised in the first batches of Schmidt locomotives. Although these superheated "simples" averaged from 4 per cent. to 10 per cent. more coal per 1000 ton-miles than the two-cylinder saturated steam compounds, the latter averaged up to 30 per cent. greater capacity to pick up time from times lost by delays on the road without exceeding scheduled maximum speeds. These small passenger compounds were, however, abandoned because it was urged that the cost of maintaining in repair boilers at 200 lb. would be higher as compared with 170 lb. in the Schmidt locomotives. Further, the excessive under-cylindering of the compounds forced their drivers to use the steam with extra long cut-offs, and this prevented realising a superior rate of expansion by 2·5 times greater than with the most economical cut-offs in simple working. Only by this 2·5 greater rate is the double expansion warranted. This continental experience for twenty years was confirmed later by the bench tests at Altoona, namely, that the lowest dip in the "simple" consumption curve per I.H.P. hour is realised between 30 per cent. and 42 per cent. cut-off. Automatic cut-off control apparatus usually auto-adjust locomotives for maximum economy between 35 per cent. and 48 per cent. cut-off in single expansion.

Referring to recent German "simple" tests, *La Révue Générale*, p. 226, August, 1927, says:—"Les nouveaux essais ont indiqué que l'admission optime pour reduire les consommations de vapeur était de 35 per cent. à 40 per cent. et non 25 per cent. à 30 per cent. d'après Strahl."

In 1906, with the revival of the forgotten railway practice of superheating by a German patents company (see Mr. Henry Fowler, Midland Railway, on "Forgotten Applications of Superheaters in Railway Service," by Charles R. King; page 6, Excerpt Minutes of "Proceedings," Inst. Civil Eng., Vol. CXCVI., Session 1913–14, Part II.), Britain and America followed the recommendations of Schmidt and abandoned compound locomotives. Thus it comes about that our thermal efficiency indicated now has a maximum of 8·22 per cent., against 8·8 per cent. in saturated steam low-pressure compound locomotives of thirty-five years ago. Engineers were then (1906) led to believe, as many still do, that compound expansion was a means partially to reduce cylinder condensations, whereas

superheating eliminated all condensations. In reality, compound expansion was, and is, a purely mechanical means for planimetrically increasing the area of the indicator cards, the M.E.P., and the indicated horse-powers and tractive efforts by 50 per cent. to 60 per cent., using any kind of expansive fluid. As Messrs. J. K. Porter, of New York, have so frequently given the cards, and also air consumptions, showing 50 per cent. power increase per unit of cold air consumed by compounding their own pneumatic locomotives, the question of heat or condensations in the fluid may be omitted altogether.

Continental engineers were less unanimous. Many held to the 8·8 per cent. thermal efficiency of saturated steam low-pressure compound engines, but followed Germany and other countries in reviving the ancient practice of superheating on railways. Up to 1912–1913 the use of higher pressures, improved valves and valve settings, longer valve travels, the generalised use of drifting valves, and the return to superheating—which alone augmented efficiency by up to 25 per cent.—the increment of efficiency (1891–1913) totalled up 45 per cent. equally in compound as in simple locomotives, as follows :—Compounds, 1891, $8·8 \times 0·45 + 8·8 = 12·8$ thermal efficiency, 1913; simples, 1891, $5·7 \times 0·45 + 5·7 = 8·2$ thermal efficiency, 1926.

As with all engineering matters, it requires constant industrious perseverance, without faltering or deflection from one's purpose, to succeed with any one thing. The best example of this is given by the P.L.M. Railways of France, which introduced compound expansion for all categories of locomotive service in 1888, and exhibited the first examples of balanced compounds at the Paris International Exhibition of 1889—black inconspicuous objects, just behind the gaily coloured William Blount of the L.B. and S.C. Ry.—which Mr. Henry, later on, tried for speed on the P.L.M. Ry. Since that time, when there was only about 20 per cent. coal saving by the compound expansion (while the boiler pressures have never been increased for close on half a century), the P.L.M. has unwaveringly employed compound expansion for all its services and now (with perhaps the exception of Prussia) holds the world's record for the highest power per ton of steam (= 172 I.H.P.) and per ton of engine weight for superheated steam (= 27 I.H.P.) By constant specialisation in compound power locomotive engineering it was better able to improve the efficiency of the ninety odd simple "Pacifics"* by which, under Mr. Chabal, in 1909, an attempt was made to break the continuity of the advance on the P.L.M.

The P.L.M. brochure of the Turin Exhibition, 1911, showed the test efficiency of these engines (simples) under Mr. Chabal, and the P.L.M. brochure of the Ghent Exhibition, 1913, showed how vastly the "simples'" power had since been increased under Mr. Maréchal. The Engineer, page of official figures from dynamometer tests, page 509, June 8th, 1917, shows, however, that over these much-improved simple engines—the finest of which there is record—the return to compound expansion had effected an immediate thermal efficiency increase of 54 per cent. at the draw-bar.† The first low-pressure Mallet two-cylinder tank engines also advanced the thermal efficiency by 50 per cent., as expressed in 1000 ton-miles haulage power increase on the P.O. Ry., just fifty years ago. In Austria 50 per cent. to 53 per cent. thermal efficiency increase was realised by compound engines, with both three and four cylinders, having ratios of volumes H.P. : L.P. = 1·3. In Sweden the 50 per cent. thermal efficiency increase can be demonstrated in an instant. Working "simple," with superheated steam, the Swedish cards indicate the same M.E.P. and same I.H.P. as the best obtainable from English and Prussian "simple" locomotives at the same speeds and cut-offs. But immediately that a pass valve diverts the exhaust steam from the chimney into a second cylinder, 2·3 times larger than the H.P. cylinder, then the total tonnage indicated on the pistons augments immediately by about 53 per cent., as an average. The boiler pressure and the cut-off remain unchanged, and 50 per cent. more work is indicated by the steam without any increase in its consumption per hour. Than this complete series of cards nothing has so strikingly demonstrated the 50 per cent. power increase of double expansion.

By a similar device trains are able to ascend steep racked railways in Switzerland and in our Colonies. Without the 50 per cent. power increase by the second expansion the trains would be stalled almost as soon as the steep racked incline began. The virtue of the system appears here in small boilers and light engines of a high power quite impossible without 30 per cent. greater weight in single expansion locomotives, and as was shown in some Württemberg comparative trials of the Winterthur system against enormously heavy smooth rail "simples."

Considering the signal failures which have followed almost invariably, all attempts to apply the compound principle to locomotives in this country, the more unfortunate importation of semi-simple de Glehn "compounds," and the very moderate success of the now out-of-date engines introduced by Mr. Deeley on the Midland Railway—even while granting that these four-coupled engines save the burden of the heavier six-coupled "simple" engines, that would exceed permissible total loads on the permanent way works of the Midland main line—it would not be possible for British designers to increase straightway, by fresh attempts, the train loads hauled by 50 per cent. on the present fuel consumptions. At present they are so completely out of thought and practice in modern compound engineering that time and money would be wasted in the new study for producing locomotives of 50 per cent. higher thermal efficiency. The source of the power in compound expansion is revealed by the indicator. The new U.S.A. and U.K. locomotives of 250 lb. boiler pressure (two, three and four cylinders) release their steam, with a cut-off of 70 per cent., at 200 lb. per square inch. Swedish compounds generate steam at 180 lb.

The factor of adhesion is lower in compound than in simple engines because the variations of piston loadings from maximum to mean, as plotted from indicator cards in polar diagrams of crank efforts, are less sudden. Auto speed records have shown The Engineer readers that the acceleration is the same with an express train of 635 tons behind a compound as with a train of 460 tons behind a "simple" of the same weight.

The subject is a vast one upon which there are no treatises or text-books in any language of any value to-day. The fringe of the matter has scarcely ever been touched in this country. Nothing less than practical demonstration with engines of the most up-to-date compound design is likely to open the eyes of railway directors and shareholders—and none too soon either with the keen struggle between road and rail transports.

October 7th. Charles R. King.

* The Engineer, page 323, September 29th, 1911.

† The Engineer, Double-page Supplement, December 14th, 1917.

Sir,—I have read the correspondence on the above subject and believe that the following data may be of interest for Mr. Keiller and Mr. Riekie. The Italian State Railways built towards 1906 four types of compound locomotives, viz., groups 600, 630, 730, and 680 respectively. Their characteristics are as follows :—

Axle arrangement	2-6-0	2-6-0	2-8-0	2-6-2
Cylinders, number	2	2	2	4
Wheels, driving, diameter	5ft.	6ft. 0·84in.	4ft. 6in.	6ft. 0·84in.
Pressure, lb. per square inch ..	200	200	200	228
Driving axle load, tons	14·5	14·5	14	15
Weight of engine loaded, tons ..	53	54	65	70

These four locomotives gave good service and showed an appreciable economy as compared with other simple expansion engines of similar total weight. The defects which these four types of locomotive showed were :—

(1) With two cylinders it is difficult to obtain balance of power between them and therefore the engine is apt to work unsymmetrically.

(2) With two cylinders the number of blasts is low—only two per revolution—and this gives an uneven draught at low and medium speeds.

N.B.—The four-cylinder engine also showed these defects, as both the H.P. cylinders were on the left side (one outside and one between frames) and both the L.P. on the right of the engine.

Later four sets of simple superheated steam engines were built, bearing group numbers 625, 640, 740, 685. The frames are identical to those of the engines of the previous groups, and so are the boilers, except for the superheater and for the pressure, being lowered in all four cases to 170 lb. The cylinders were made somewhat large to deal with superheated steam.

The comparative results showed that the superheated engines were superior to the compounds both in water and coal consumption. Furthermore, they steamed more evenly and started and pulled more evenly, too.

The conclusion to which the Italian State Railways have come is that simple superheated engines are better than saturated compounds, saturated compounds are better than saturated simple expansion engines, superheated compounds are better than all as far as efficiency is concerned. However, one must consider first cost, which is greater in the more complicated engines and the repair costs and reliability, too. The value of these items is not everywhere the same; in England and in all countries where fuel is good and cheap efficiency is rightly less considered, and certainly to obtain the lowest total final cost per ton-mile hauled in England the use of complicated locomotives is less justifiable than in Italy. Furthermore, the size and use of the engine have a bearing on the convenience of making it complicated and economical.

Now, the Italian State Railways would build single engines only for very small shunting classes; for medium and fairly large engines they would use simple superheated engines, and for exceptionally heavy and powerful engines they would use superheated steam and compounding. Such is the case in recent 2–8–2 and 2–10–0 engines, which are four-cylinder compounds of about 90 tons weight with 17 tons on the drivers and with boilers working at 228 lb.

To conclude, I believe that whilst in England, speaking in general, the English love of simplicity and reliability and the low cost of good coal has retarded the use of efficient locomotives; on the Continent several types of engines could have been made simpler with little or no loss of efficiency.

Probably considering all the factors which influence their design, the best English and continental engines are both not so far away from the "golden middle way" as they may appear to be.

Comparisons are interesting, but unless they are made under very special conditions they are never quite fair to all parties. Should your correspondents wish for further data on the Italian engines described above, I will be glad to forward them any information I have. V. Pecori.

Milan, October 7th.

Sir,—I am afraid an error has crept into the transcript of my letter of the 3rd inst., which you kindly publish in this week's issue of The Engineer. In referring to the indicator cards published by Mr. C. R. King in another journal the cut-off of the high-pressure cylinder should be 70 per cent., not 7 per cent. as stated.

I should be much obliged if you would insert this correction, as the slip spoils the sense of the paragraph.

Cookham Dean, October 10th. C. M. Keiller.

RAILWAY ECONOMIES.

Sir,—The railway companies are, I understand, expecting to make considerable economies by substituting—for ordinary passenger trains, which are so under-filled—a largely increased number of light motor coach trains. I am wondering why this same method of working should not be applied to goods trains, it being, I believe, at present, for the bulk of the traffic carried, difficult to get full truck loads of goods.

My suggestion is that trucks of a size to carry a full load of, say, 2 tons should be constructed. Such trucks would be much lighter to haul and much cheaper to construct than the present 8-ton load trucks, and it would, I think, be quite practicable so to design these smaller trucks that the present 8-ton wagons could, if desired, be intermixed and run with them.

Worcester, October 10th. Joseph Southall.

DERAILMENTS AND WHEEL FLANGES.

Sir,—Like some of your correspondents, I am very much interested in railway matters. With your permission, I will introduce the locomotive wheel flange as a probable cause of some derailments, if it is allowed to become sharp. I think all will agree that the wheel flange has little to do on a straight road, but the moment the engine comes to a curve the flange strikes the outside rail and hugs that rail just as long as it is running on a curve, all the time trying to climb the rail, because the law of motion is operating; the engine wants to go straight, the curved rail prevents it. Through so much rubbing of the flange on the outside rail it becomes worn or sharp and offers every inducement to climb the rail at a slack joint, crossing or points.

There are several reasons for wheel flanges requiring close attention. Sometimes in a pair of wheels one tire is of softer material than the other, the tread of the soft tire wears much quicker than the other; the consequence is that the larger wheel is always running in front of the other, the smaller wheel flange suffering thereby. The same result must follow if there is a difference in the diameter of the wheels coming from the lathe.

If you take a pair of wheels lying loose in a straight road you will find that they can be moved easily, but when you come to a curve you may require assistance to keep them moving. Now notice what is happening and you will find it is the outside rail again. I have seen occasionally derailment with loose wheels, while shunting from one road to another, the outside rail just acting like a brake. What is happening with a loose pair of wheels is just the same when under the engine. It must be self-evident that the longer the engine the greater the pressure on the flange while on a curve.

I conclude by saying, mind the flange and keep it round so that it will not grip. Progress.

October 7th.

MODERN BUSINESS METHODS.

Sir,—Would it be in order to submit through the medium of your correspondence columns that much sound business is lost or delayed by reason of the telephonic and other interruptions that are now allowed in almost every office to occur during business interviews? To the inventor engaged in an exact and precise explanation of his invention to his patent agent, *e.g.*, interruption is anathema. Yet how often in the case of the large firms is it permitted with the formal words "excuse me." Worse still when it occurs when the unfortunate inventor is attempting to interest capital and to explain some subtle point to the capitalist's experts. Yet here again, and indeed in every business transaction of these entirely self-destructive times, does it occur.

May I submit that if a man is worth a hearing at all he is worth hearing without interruption, and in the general business interests of the country may I suggest that principals or those who act for them, having granted an interview on a tricky subject, see to it that the interview is without distraction?

Indeed, in the case of professional firms such interruption amounts to "negligence" in the legal sense, and the client should be protected for that amount of time for which he pays.

October 5th. Simple Simon.

GERMAN EXHIBITS AT THE MACHINE TOOL EXHIBITION.

Sir,—I beg to advise you that I have resigned from the Council of the Machine Tool Trades' Association, and my company, the Selson Engineering Company, have resigned also from membership of the same Association.

Our reason for this action is that the Association have decided that no German machine tools shall be exhibited at the forthcoming Exhibition.

There is no need, I think, for me to outline any of the arguments on the matter, but merely to state, in my opinion, that there are only two alternatives open to any self-respecting association :—(1) That the Exhibition should be frankly international and that every country should be allowed to show the best of its products; (2) that the Exhibition should be confined only to British products.

I am fully convinced that the bulk of the members of the Association agree with me in my contention and that the third alternative, namely, that machines of American, Swiss, Belgian, French, Czecho-Slovakian, Italian and Austrian manufacturers may be shown—but not German—is one that cannot command respect.

I should be extremely glad to know what is the opinion of the purchasers of machine tools throughout the British Empire.

The Selson Engineering Co., Ltd.,
H. M. Selson, Managing Director.

London, E.C. 1, October 7th.

The Institution of Mechanical Engineers.—The ninth award of the Water Arbitration Prize will be made for the best original paper dealing with "The Utilisation in Engineering Production of the Plastic Properties of Metals," accepted by the Council for publication with or without discussion in the Institution "Proceedings" of 1927 and 1928, provided that the paper be of sufficient merit in the judgment of the Council. It is intended that the title should cover the manufacture of articles by methods other than cutting, *e.g.*, stamping, extrusion, rolling. Papers should be sent in as soon as possible, but not later than April 1st, 1928. They should be illustrated by scale drawings, but may be accompanied by photographs, lantern slides and specimens. Any paper not accepted for printing in the "Proceedings" will be returned to the author. The prize will have the value of about £30, and will be accompanied by a certificate bearing the seal of the Institution.

The Engineering Golfing Society.—The autumn meeting of the Engineering Golfing Society was held at Wentworth, near Virginia Water, on Thursday, the 6th inst. In the morning there was an eighteen-hole medal round and the "Hele-Shaw" Scratch Challenge Cup and Memento were won by C. R. D. Pritchett with a score of 81. The handicap prizes were taken as follows :—First Division—(handicaps 10 and under)—first prize, E. C. MacKellar, 82 — 4 = 78; and second prize, D. B. Mansergh, 85 — 5 = 80. Second Division—(handicaps 11 and over)—first prize, W. W. Hughes, 87 — 11 = 76; second prize, H. P. Allison, 93 — 16 = 77. The prize for the best first nine holes fell to W. L. Mansergh; and the prize for the best second nine holes to P. B. Brown. In the afternoon there was an eighteen-hole round, foursomes against bogey, when the "Hadfield" Challenge Cups and Mementoes were won by G. G. Elliott and H. G. Hale with 1 up; the second prizes going to C. R. D. Pritchett and A. P. Patey with 1 down.

Inventions Exhibition.—There certainly was an air of inventiveness among the people who foregathered on Wednesday to inaugurate the third Exhibition of Inventions, organised by the Institute of Patentees, which is being held in the Central Hall, Westminster, and remains open until the 22nd inst. But one is left with the impression that the average inventor requires much more assistance and advice as to the commercial possibilities of his ideas than he generally receives, for a vast amount of time and energy must be expended on "inventions" which have no possibility of success. There are, nevertheless, quite a number of ingenious exhibits at the show, although not much of technical engineering interest. In his speech at the inaugural luncheon, Viscount Burnham put the British inventor as being pre-eminent, and pointed out how scientific invention helped in the amelioration of the conditions of life. He mentioned, for instance, the steam navvy as an example of an invention which had substituted mechanical force in the place of hard and rough manual labour. Lord Askwith said that in quite a number of cases the Exhibition had been instrumental in bringing inventors and manufacturers together.

Railway Matters.

The principle of co-operation between the officers of railways and their men, by which the latter aim to increase the business of the companies, has now been adopted by the Metropolitan Railway.

Fleetwood was very much *en fête* and kept "open house" on Friday and Saturday last to celebrate the jubilee of the opening of the docks there. It is not generally known that there are publicly-owned and privately-owned docks at Fleetwood; they are not all the property of the London, Midland and Scottish Railway Company.

In a letter in *The Times* of the 7th inst., the official shorthand writers appointed by the Ministry of Transport give the following particulars of the meetings of the Rates Advisory Committee and the Railway Rates Tribunal:—Number of days' hearing, 200; number of pages of tables, &c., 350; number of questions asked, 65,559; number of words spoken, about 7,306,000.

The German Railways Company and our Great Western Railway Company have agreed to exchange an officer for a period of one or two years. The German officer to come to England is Mr. F. C. Hardt, who had charge of the students who visited England as related herein on May 6th last. The Great Western officer, who will temporarily join the German Railways, is Mr. L. J. L. Lean, of the office of the superintendent of the line.

The thorny question of railway shopmen which for some years has been a point of dispute between the National Union of Railwaymen and the other trade unions, with the railway companies standing helplessly by, has now been settled. An agreement was signed by the parties concerned, and it is of interest to note that one clause provides against any withdrawal of labour or unauthorised action pending negotiations. The number of men affected is 120,000.

The Ministry of Transport railway staff census, price 2s. 6d., shows that during the week ended April 30th last there were 689,264 persons employed on British railways, exclusive of those engaged on such auxiliary businesses as canals, docks, steamships, &c. That indicates a decrease of 6187, when compared with the week ended March 27th, 1926, but we find, on reference to previous returns, that in 1921 there were 737,285 employed, so that in six years there has been a reduction of 54,208. In 1913, however, and so before the eight hours' day, the number was 618,308.

The first step, in a scheme for the establishment by the Canadian National Railways of a new terminus in Montreal, involving the expenditure of many million dollars, has been taken, the Canadian Government having authorised expropriation proceedings for the required site. There are at present two stations, those of the former Grand Trunk and Canadian Northern Railways now included in the Canadian National system. The railway authorities have decided to link up the different lines and concentrate station and other facilities near the present tunnel station on Dorchester-street. The construction of the new station will also largely remedy the evil of level crossings, which has lately been receiving attention from the Railway Commission.

The Ministry of Transport railway statistics for July last, recently published as a Stationery Office publication, price 3s. 6d., not only show, when compared with the corresponding period of 1925, a continued falling off in passenger traffic, but, for the first time for some months, a drop in the freight traffic, and, despite the increase in most rates made last February, a decrease in freight receipts. Passenger journeys decreased 4·5 per cent. in number and 4·4 per cent. in their payments. Freight tonnage fell by 7·8 per cent., wholly accounted for by a drop of 11·8 per cent. in the coal tonnage, whilst the freight receipts decreased by 5·1 per cent. There was a corresponding reduction of 4·4 per cent. in the freight train mileage.

In this column of our issue of May 20th last reference was made to a collision on the previous Saturday at the Sheffield Station of the London, Midland and Scottish Railway, when a light engine collided broadside with an arriving up Scottish express. Colonel Sir John Pringle inquired into the accident, and his report thereon has recently been issued. From that document it seems that after proceeding along No. 9 road from the north to the south end of the station, the driver of the light engine was stopped and told to go back on the same road. The signal for that line in the middle of the station was "off," but the man overlooked the signal at the exit. That was "on" because of the approaching train, and the collision resulted. The only matter of comment made by Sir John Pringle relates to the locomotive running department not advising the station staff of a change in the engine arrangements. A tank engine usually worked a certain train, and when a goods engine arrived at the north end its identity was not known, and it was sent forward to the south end. Otherwise the engine would have been turned direct into the line where its coaches were.

Wednesday, October 5th, was the fiftieth anniversary of the opening of an important Scottish railway connection, i.e., that between Girvan on the Glasgow and South-Western, and Challock Junction on the Portpatrick Railway, a distance of 30¼ miles. The line was sanctioned in 1865, but construction was not begun until 1872, and took five years to complete. There were three big viaducts besides other bridges on the line, and, at the summit, 600ft. above sea level, a tunnel 540 yards long. In September, 1875, floods washed away four of the bridges, and twice during construction the embankment at one place was engulfed. The Portpatrick Railway was then owned by an independent company, and it was not until 1885 that it and the Wigtownshire became the Portpatrick and Wigtownshire joint line in order to develop the Stranraer and Larne route to Ireland. Powers were given to the Girvan and Portpatrick Railway in 1872 to make agreements with the Portpatrick Railway, with a view to running to Stranraer, but those agreements had not been concluded when the line was ready, and the Portpatrick Railway obtained an order to prevent its line being used and the Glasgow and South-Western Railway, which company was working the Girvan line, had to stop at New Luce, 5¼ miles short of the junction.

Notes and Memoranda.

According to the officiating Director of Agriculture in Burma, it is estimated that in the Tavoy and Mergui districts alone there are 120,000 acres suitable for the extension of rubber planting. This area comprises only the more level lands and gentler slopes, but in addition, there are steeper lands which might possibly serve for planting schemes when the more eminently suitable sites have been taken up.

Following the recent closing down of the experimental oil shale plant of the United States Bureau of Mines, Department of Commerce, near Rulison, Colo., studies of the best methods of refining shale oil are being made at a number of institutions. Some of the oil produced has been sent to the Boulder, Colo., laboratory of the United States Bureau of Mines, where studies are being made in a 10,000 dollar experimental refinery erected by the State of Colorado. The results of these investigations will be made known to the Bureau of Mines.

Amongst the vegetable oils, the most dangerous in the way of spontaneous combustion when soaked up in waste is linseed, cotton seed, and nut oils closely following. Animal oils, when pure, are less dangerous, but when impure, and particularly when rancid, are fully as dangerous as the vegetable oils. Mineral oils have practically no affinity for oxygen, and, when pure, are not subject to heating, but if impure or adulterated with animal or vegetable oils, as they often are, or impregnated with sulphur or iron sulphides, they become dangerous.

Recent additions to the metallurgical equipment of the Birmingham Central Technical College include a Reichert photo-micrographic apparatus and electrically driven rolls for hot and cold rolling. An improvement has been effected in the electro-plating and metal colouring department by the conversion of all the lathes into separately driven units. A metallurgical society has also been formed, of which the principal, Dr. Johnson, is president. This society is run by the students themselves, and has for its object the encouragement of discussions and debates on metallurgical topics. Works visits have also been arranged.

According to the special commissioner of the *South African Mining and Engineering Journal*, there is what seems to be an ideal storage site available for the mining district of South West Africa in the granite foothills of the Erongo, behind the farmhouse on Davib East. A deep gorge in solid granite could be closed by a dam which, for an estimated cost of £40,000, would conserve 8,000,000 cubic metres, or 1760 million gallons of water. The run off in the catchment area, which is considerable, must be nearly 100 per cent., as the area is mostly massive granite. Moreover, the western end of the Erongos is one of the wettest spots in the territory.

In explanation of the failure of a 300 kW turbo-generator which had been laid idle for some six months, the engineer of the Vulcan Boiler and General Insurance Company makes the following suggestion: "Upon a careful examination of the armature, the slot covers were found to be pressed out of shape and to show signs of movement. The only solution of the breakdown that can be offered is that during the six months the generator had lain idle the slot covers, being of fibre, absorbed moisture, and became sufficiently damp to be slightly pliable, and that whilst the drying out to which the machine was subjected before it was set to work was sufficient for all ordinary conditions, it was not enough to restore the hardness of the fibre, and one of the slot covers was forced out of position.

The British Commercial Secretary at Cairo reports that, exclusive of tractors, the total number of motor vehicles imported into Egypt during 1926 amounted to 4762, valued at £E747,024, as compared with 5491 worth £E764,423 in 1925. The United States was the chief contributor, with 2421 vehicles, valued at £E262,144, consisting for the most part of Ford products, with a fair number of more expensive cars, and representing a decrease of 1043 in number and £E37,600 in value as compared with 1925. United Kingdom imports amounted to 270, valued at £E61,172, as compared with 302 (£E73,618) in 1925; Italy's contribution was 1156 (£E222,589), which constitutes an increase in numbers of 132 and in value of £E2104 over 1925; French imports also increased, viz., to 752 valued at £E167,504, from 648 worth £E154,171. Belgian imports—which were mostly confined to Minerva cars—increased; but so far this competition cannot be looked upon as formidable. It is satisfactory to note that imports of motor cycles from the United Kingdom increased in number, although values were very slightly reduced. Out of a total import of 241 valued at £E11,351, the United Kingdom supplied 168 worth £E7983. It is a point of interest that while competing countries are stocking their agents fairly heavily in proportion to the market demands, United Kingdom products appear to sell much more steadily.

In cases where a "run-through" system is used for the water cooling of an oil or gas engine, it frequently happens that an attendant stops the engine and at the same time cuts off the water supply. This, of course, happens automatically where a circulating pump driven by the engine is in use. A certain amount of water remains in the ports and pockets of the cylinder head and jackets, and this becomes overheated due to the heat abstracted from the walls of the combustion chamber, &c. Scale is thus often formed, and at the same time a portion of the water is evaporated, leaving what subsequently become air locks, whereby the subsequent admission of cooling water is impeded. The result of these air locks is that local and severe overheating of the metal is liable to occur, with considerable danger to the casting, particularly if the metal becomes seriously overheated whilst dry, for then the air lock is subsequently disturbed and the water reaches it heated surface. It is therefore essential that whenever the "run-through" circulating system is used, provision should be made for maintaining the flow of water through the jacketed portions for at least a quarter of an hour after the engine has been shut-down. Wherever possible, a small tank should be fitted overhead, so that the supply passes through it. This tank will do much to prevent accidents due to failure of the circulating water supply.

Miscellanea.

A new bridge is to be built across the river Hull, in place of the existing North Bridge, at a cost of £36,100.

The Craven Colliery of the Warwickshire Coal Company is to be closed down, on account of the inrush of water.

The Stockton Steel Foundry has been acquired by Head, Wrightson and Co., and is to be reopened very shortly.

Southern Rhodesia's output of chrome for the first seven months of the present year amounted to 164,397 tons. The production of asbestos for the same period was 20,147 tons.

It is officially stated that diamond drilling in the Cholmsford District of Ontario has disclosed a series of lenticular bodies of lead, zinc and copper ores amounting to about 1½ million tons.

The new alternator for the Willesden power house of the London Power Company, which was made by the English Electric Company, was recently taken all the way from Stafford by road. It weighs 67 tons.

The Canadian Government is increasing its air service and has ordered twenty-six additional aeroplanes and equipment at a cost of over 400,000 dollars. It will give two planes to each city where a flying club is established, which will undertake to maintain the aircraft.

Work has been begun on the erection of the large paper mill of the Spruce Falls Power and Paper Company at Kapuskasing, Ont., which will have a capacity of 550 tons. The corner stone was laid on September 20th by Premier Ferguson, of Ontario, in the presence of a large assemblage.

The Argentine Government has placed a contract for 45,000 tons of steel rails with the United Steel Companies, Ltd., which will obviate the necessity of a cessation at the company's Workington branch. The order will ensure full-time work for several weeks. The company recently re-started its tire mills at Derwent Works.

The Province of Quebec is joining the growing movement for reforestation in Canada, and is this year planting 1,600,000 trees on Government lands. It is anticipated that in another two years the Government will be planting 5,000,000 trees annually on Crown lands to replace those that have either been cut down or burned.

The commencement of the 1927–28 session of the Institute of Metals coincides with the opening of new offices of the Institute, and of an additional library and reading-room at 36, Victoria-street, London, S.W. 1. In March next the Institute celebrates its twentieth anniversary, and it is expected that by then the membership will have increased to 2000.

The Montreal Island Power Company has prepared plans to develop 48,000 H.P. on a site at Back River, where there is a head of 26ft. capable of generating 65,000 H.P. All the engineering details have been worked out as planned, and everything is now in readiness for the awarding of the contracts for the various parts of the work. The contract for a railway to the site has already been awarded to the Foundation Company of Canada, Ltd.

A demonstration of sugar beet lifters and harvesting machinery, organised by the Institute of Agricultural Engineering, University of Oxford, will be held at the Home Farm, Buckland, near Faringdon, on Tuesday, October 25th, and at Mr. R. J. Wilsden's, Northmoor, on Wednesday, October 26th. About a dozen of the principal British makers will be represented, and entries have also been received from Belgium, France, Germany and the United States. The demonstration will start at 11 a.m. and continue until 3 p.m. each day.

At a luncheon given by Leeds Rotary Club recently, Dr. A. Gilligan, Professor of Geology at Leeds University, spoke on "Our Iron Supplies." He said that probably the first iron used came accidentally to the hand of man. Some of the ores would be so acted upon by forest fires as to be reduced to the metallic state, and man adapted it to his use. A noted Swedish geologist predicted that supplies would run out in about a hundred years; and Sir Robert Hadfield said that within that period supplies would be so small as to make man look round for some other material. Cleveland would probably use up its iron supply within the next thirty years.

The British Columbia Electric Railway Company, Ltd., announces plans for the erection of a large gas plant and tank to cost 650,000 dollars. The new plant will have a capacity of 3,000,000 cubic feet of gas daily, and the tank capacity will also be 3,000,000 cubic feet. The present capacity of 6,000,000 cubic feet is sufficient, Mr. John Keillor, the gas engineer, says, to meet this winter's requirements only, and the new addition will suffice until 1932. The company estimates that Greater Vancouver will require 25,000,000 cubic feet of gas by 1947, to meet which an ultimate expenditure of 5,600,000 dollars will be required during the next twenty years.

Members of the Nottingham section of the Association of Colliery Engineers have paid a visit of inspection to the all-electric Thoresby Colliery, belonging to the Bolsover Colliery Company, near Chesterfield. Sinking at this pit is now down to about 320 yards, and it is expected that coal will be struck at a depth between 550 and 650 yards. The Thoresby Colliery is an example of the latest practice in the lay-out and equipment of a modern colliery. It is situated on the borders of Sherwood Forest, and in order to preserve the natural beauty of the surroundings, it was essential that no steam or smoke should issue from the surface workings. Power is brought to the colliery by an overhead ring main at 22,000 volts from the company's plants at Bolsover and Creswell to the north, and Clipstone, Mansfield, and Rufford to the south, thus providing alternative supply lines and reducing the possibility of failure to a minimum. At each of the collieries mentioned there are British Thomson-Houston mixed-pressure turbo-alternators generating three-phase current at 2200 volts, 50 cycles. The pressure is stepped up to 22,000 volts for overhead transmission, the line and switchgear being so arranged that any two collieries can interchange current without in any way affecting the supply to their own plant or to Thoresby. The B.T.H. Company, Ltd., has been the electrical contractor for the plant.

OIL-DRIVEN PUMPING PLANT AT WALTON

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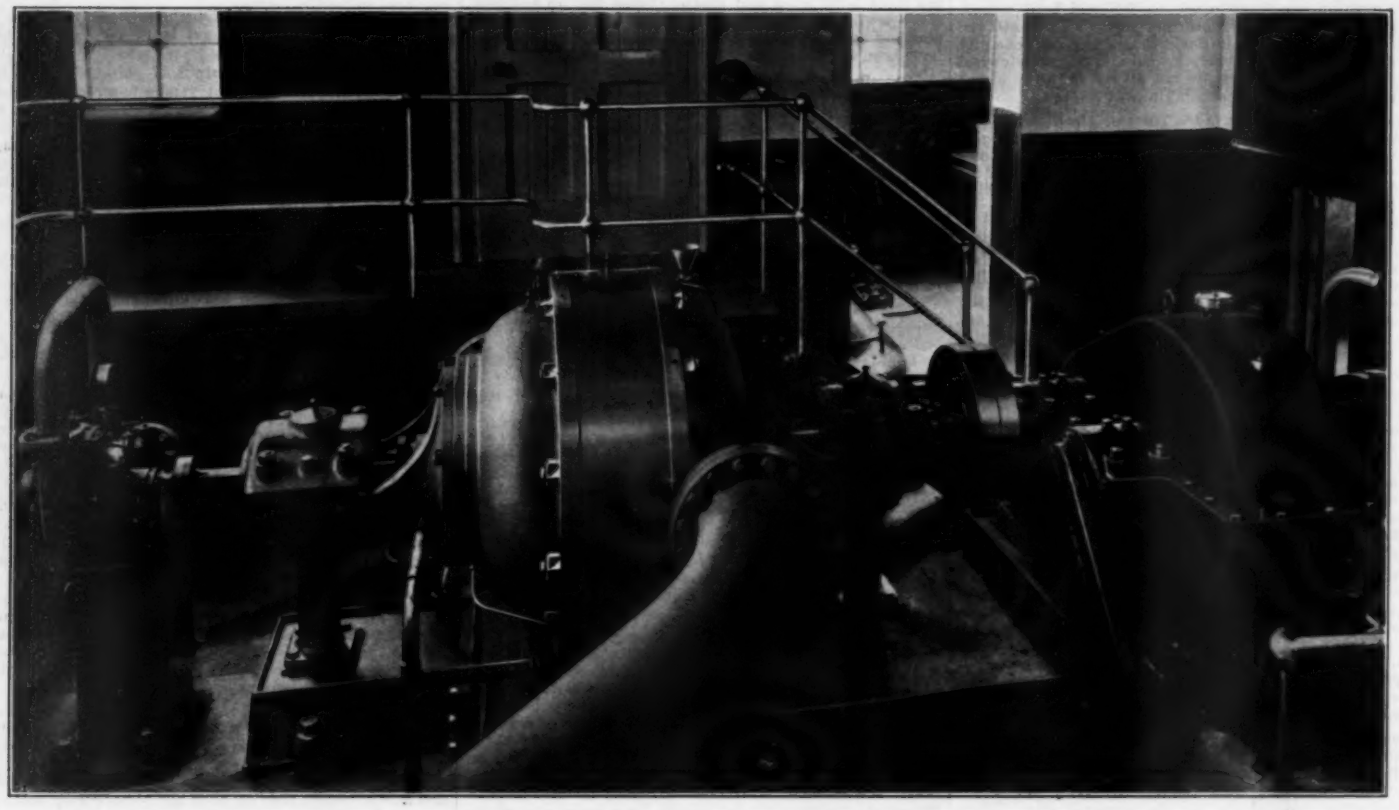
(*For description see page* 435)



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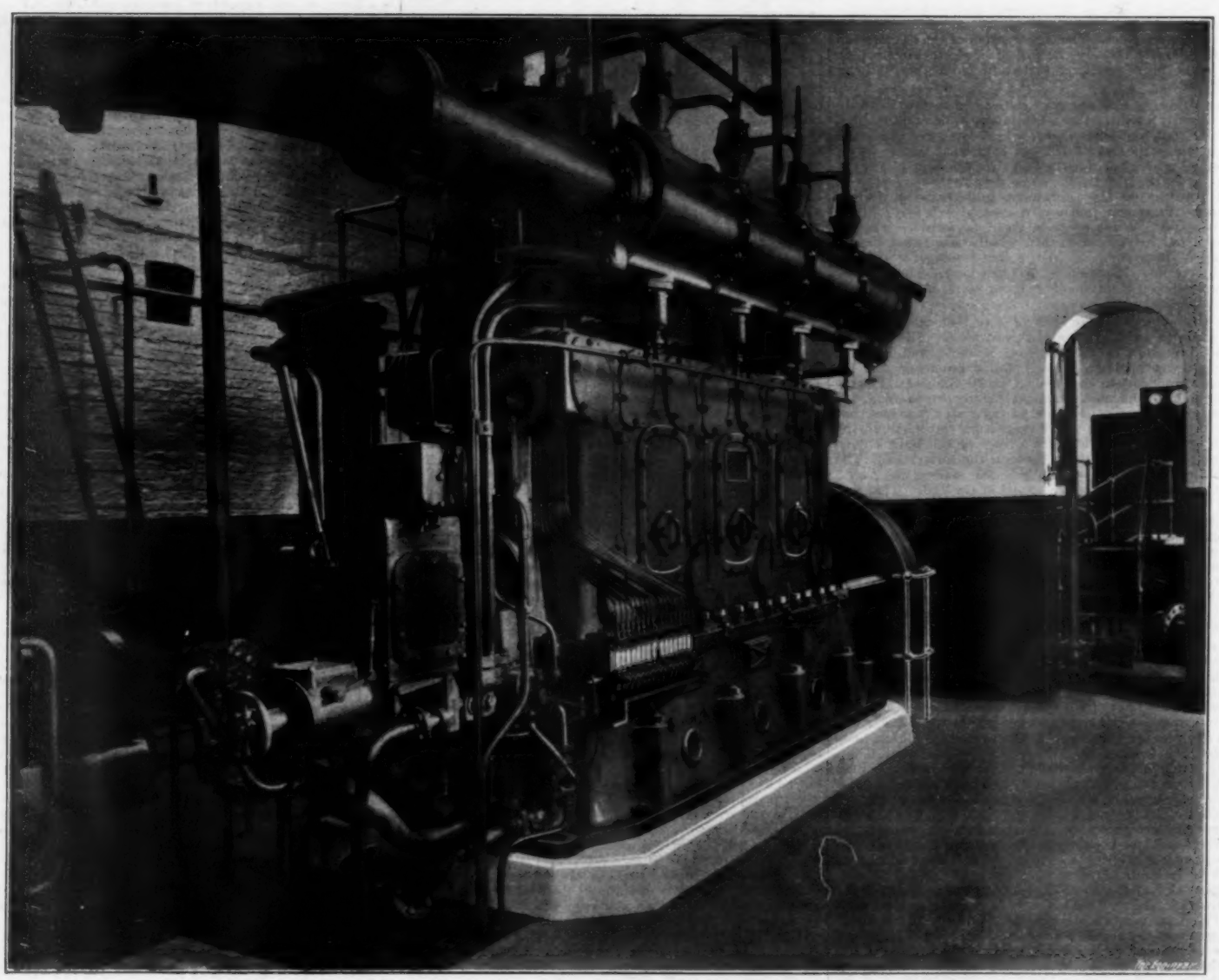

ENGINE HOUSE WITH PUMP HOUSE IN BACKGROUND

The Engineer

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THE ENGINEER.

OCTOBER 14, 1927.

British and Foreign Cruisers.

IN the course of the recent Naval Conference at Geneva, it was stated by one of the technical delegates that the design of a capital ship often came under consideration three years before the vessel was actually laid down. It is therefore quite possible that tentative plans for the "replace" battleships which are due for commencement in 1931 are even now being discussed by the various Admiralties concerned. For the present, however, a more practical interest attaches to the design of cruisers, a type which is not yet subject to numerical limitation by international agreement, and is being actively developed by all the major navies. There are, it is true, restrictions on the size and armament of these craft. No new cruiser must exceed 10,000 tons with bunkers and feed-water tanks empty, nor must the calibre of its guns be more than 8in. Because these limits have been almost universally adopted as the minimum in each case, a certain uniformity characterises all the large cruisers now under construction. Never before in the history of naval construction have five countries been building simultaneously warships identical in tonnage and armament. This phenomenon is doubtless a logical corollary of the naval limitation movement, but it is deserving of notice for all that. Within the limits imposed by the Washington Treaty the naval constructor may still find scope for the exercise of his ingenuity. Unfortunately, the prevailing tendency to reticence in all that pertains to the design of warships makes it impossible to institute anything more than a superficial comparison between the latest cruisers of the various navies. The most arresting feature of our own cruisers, *i.e.*, the "County" class, is their relatively low speed. They are engined only for 31½ knots, while the corresponding Italian ships are designed for 34, the French and the Japanese for 33, and the American cruisers for 32½ knots. Since our naval constructors are second to none in professional skill, it goes without saying that sound reasons must exist for this deliberate acceptance of inferior speed. We know from the public utterances of Vice-Admiral Sir A. E. Chatfield and other officers of war experience that mere velocity is no longer prized as it used to be by British tacticians. They are not ready to purchase it at the cost of hitting or resisting power, and it is therefore a safe assumption that the moderate speed of the "County" cruisers is due in part to increased protection. They are known to have bulges, and this very important means of defence against torpedo attack is apparently wanting in the foreign ships.

While at first the natural impulse was to build new cruisers up to the full limit of tonnage and fighting power permitted by the Treaty, we were always of opinion that motives of economy would lead, sooner or later, to a departure from the standard 10,000-ton type. This has already happened. Of the sixteen British cruisers to be built under the programme which Parliament sanctioned two years ago, nine belong to the 10,000-ton "A" class and seven to the 8000-ton "B" class. H.M.S. York, the first "B" cruiser, is now under construction at Palmers' yard, Jarrow. She is, it appears, a smaller replica of the "County" type. The designed speed has not yet been disclosed, but it is known that she will carry six 8in. guns. The arming of cruisers with guns of the heaviest calibre permissible has long been advocated in these columns. Before, and even during, the war, there was a tendency in naval circles to make a fetish of the 6in. gun for cruiser work. That this weapon has great merits, none will deny. The effective range of the latest mark is only limited by normal visibility; with a well-trained crew it can be discharged at least eight times a minute, and its 100 lb. H.E. shell is extremely destructive when the target is a lightly armoured or unprotected ship. Nevertheless, it is no match for the 8in. gun, and a duel between two cruisers of the same tonnage, one armed with 6in. and the other with 8in. guns, would inevitably end in victory for the latter if the *personnel* were equal in efficiency. With mechanical loading gear a very rapid fire can be maintained from the modern 8in. gun, probably four rounds a minute per gun when the weapons are twin mounted, and the 250 lb. projectile not only carries an explosive charge three times heavier than that of the 6in. shell, but can penetrate armour of medium thickness at a considerable range. The "B" type cruisers of 8000 tons will therefore be very formidable ships, possessing a marked tactical superiority over every 6in. gun ship, and able, if need be, to engage even the 10,000-ton cruisers without undue risk to themselves. If this medium type of cruiser should turn out a success it will probably be adopted by other navies in preference to the larger and more expensive ship, which eventually may disappear. In the meantime there are several cruisers under construction abroad which are remarkable for their combination of speed and gun power on a moderate displacement. Of these, the two Argentine ships Almirante Brown and Vinte-Cinco de Maio, building in Italy, deserve special notice. They have a length of 542ft., a breadth of 58ft., and a normal displacement of 6500 tons. The turbine machinery is of 85,000 shaft horse-power for a speed of 32 knots. The main armament consists of six 7·5in. 50-calibre guns in twin turrets, two of which are placed forward and the third at the stern. For defence against destroyers and aircraft there are twelve 4·7in. guns paired in turrets, three on each beam. These guns are on high-angle mountings which enable them to engage aerial targets. Six 40 mm. automatic guns and six 21·7in. torpedo tubes complete an armament that is most imposing for vessels of this tonnage. As they are able to stow 2000 tons of oil, their radius of action will be large. Although designed for the requirements of the Argentine naval service, these ships seem admirably suited to act as commerce protectors, since they are powerful enough to defeat any 6in. gun raider and large enough to keep the seas under all conditions, besides having a good turn of speed. The type, in short, has distinct advantages from the British point of view. Another interesting cruiser design comes from Germany. The first of her post-war ships, the Emden, was planned on conventional lines, but the Königsberg and Karlsruhe, both launched this year, represent a radical departure from earlier practice. Like the Emden, they conform to the limit of 6000 tons displacement imposed by the Versailles Treaty, but there the resemblance ends. The Emden, it may be recalled, is 494ft. in length, with a breadth of 47½ft., has steam turbines of 45,000 shaft horse-power for a speed of 29 knots, and is armed with eight 5·9in. guns—at present on single mountings, but subsequently to be mounted in pairs along the centre-line—four 3·4in. A.A. guns, and eight torpedo

tubes. The "Königsberg" type is 554ft. in length, with a breadth of 50ft., and has steam turbines of 65,000 shaft horse-power for a speed of 32 knots. Diesel motors are installed for propelling the ship at cruising speed. The total endurance is 6000 nautical miles. By adopting the three-gun turret, it has been possible to mount nine 5·9in. guns. There is an auxiliary armament of four 3·4in. A.A. guns and twelve torpedo tubes on triple deck carriages. The ship has a square counter in which a mine-laying port is cut, and it is understood that 100 mines can be carried. It will be agreed that the armament is of unusual power in proportion to the displacement. The three triple gun turrets are arranged on a novel plan. The first stands on the forecastle, the other two being placed *en échelon* in the after-part of the ship, the second turret on the port side and the third, at a lower level, on the starboard side. The superstructure is so modelled that No. 3 turret has a large arc of fire before the beam, while the position of No. 2 enables it also to fire at a target bearing a few points off the port bow. In chase, therefore, a very slight alteration of course would bring six 5·9in. guns on to the target. The whole design bears evident traces of having been carefully thought out, and the constructors have certainly succeeded in endowing these relatively small ships with a remarkable degree of fighting power.

Great Britain will always need numerous cruisers for the defence of the trade routes, and the smaller and cheaper these vessels are, consistent with an adequate measure of seaworthiness and fighting power, the more of them we are likely to get. As the Power chiefly interested in cruisers, the British Empire has had most reason to deplore the action of the Washington Conference in fixing the standard displacement of such vessels at 10,000 tons. The British case for reducing the size and cost of cruising ships was clearly stated at Geneva, and need not be repeated here. There are unmistakable signs of a revolt against the artificial and excessive standard approved at Washington. Great Britain is already building ships which are smaller by 2000 tons. Japan has gone further by building four cruisers of 7100 tons—that is, nearly 3000 tons under the Washington limit. Italy, after laying down two 10,000-ton ships, has reverted to the small scout cruiser. Even in the United States there is a growing demand in naval circles for a type of cruiser approximating to the British "C" and "D" ships, capable of acting either as cruisers proper or as destroyer flagships. We believe that we are justified in saying that American insistence at Geneva on the retention of the 10,000-ton standard was due, not to any special regard for this type, but to the idea that since Congress in any case would authorise only a few new cruisers, it was best to make those ships as large and as powerful as possible.

Railway Accidents.

It is not our intention, until Sir John Pringle's report is issued, to comment further upon the cause of the Sevenoaks accident, especially as the coroner's inquest is not to be resumed until the 26th inst. Nor can we, until we know the facts revealed at the Ministry of Transport inquiry, deal with the narrow escape from disaster of the West Coast express near Stonehaven on the Monday evening of last week. Yet we must in fairness to British railways devote some attention to comments made in a leading article in *The Times* of October 6th, which were prompted by the latter derailment; particularly because our illustrious contemporary remarked that "there has been a succession of recent railway accidents, not involving loss of life, but disclosing serious, if happily unrealised, perils." Six accidents were mentioned. They were that at Midgham, August 10th, bogie of engine on the Cornish Riviera express left the rails; Conway, August 17th, broken axle of tender of Irish mail; Hollingbourne, August 20th, derailment of passenger train; Sevenoaks, August 24th, derailment of passenger train; Crewkerne, September 2nd, failure of coupling of passenger coach; Penmaenmawr, September 8th, broken draw bar of wagon. Of the above six accidents, the cause of the first is not known, but that the engine was in good order is shown by it having proceeded to Swindon under its own steam. It was assumed that the sub-soil of the track was affected by the abnormal rainfall; the third and fourth cannot yet be discussed, as they have been the subject of inquiry by the officers of the Ministry of Transport whose reports have not been published, but we believe that when their causes are revealed, it will be found that they were not "Accidents of Mechanism"—which was the title to *The Times* leader. We thus have only three accidents which can justly be placed under that title:—(1) A broken tender axle; (2) a passenger coach coupling failure; and (3) a goods wagon draw bar failure.

Reference to the annual returns of accidents on railways shows that during the last six years there has been only a total of 270 failures of the axles of engines. That average of 45 failures a year applies to a total of over 24,000 engines which in 1925 ran 550 million miles. Moreover, remembering that all serious accidents are inquired into, we may note that during the last twenty-five years only two accidents caused by broken engine axles—one in 1909 and one in 1922—have been the subject of a Government inquiry. Broken tender axles are rarer still. There are nearly 15,000 tender engines and the average yearly mileage may be put down at roughly 300 millions. Yet their failures during the last six years have totalled only seventy-one, or, say twelve a year, and, what is more, not since the late 'seventies has an accident been inquired into in which a broken axle was the cause. Broken coach couplings are more frequent, no less than 2067 having been reported last year. But, as showing that no ill-results follow from such a separation, it may be remarked that no accident from that cause has given rise to an inquiry for nearly fifty years. The reason why the dangers possible from a broken coupling no longer exist is that, as happened at Crewkerne on September 2nd, the parting of the coupling separated the vacuum brake connections and both portions of the train were automatically pulled up. Broken draw bars of wagons are also comparatively frequent. Taking the year 1925, instead of the abnormal one of 1926, we find that 4525 wagon draw bar failures were reported. That figure, when compared with other failures, sounds somewhat formidable, but since there are somewhere about 750,000 wagons, which collectively run 5000 million miles a year, the failures amount to an average of less than one per million miles run. Let us add, before closing this particular phase of the subject of railway accidents, that during the twenty-five years of the present century, 2528 failures of axles of every kind have been reported, as compared with 2495 in only the five years 1876–1880, and 2109 in 1881 to 1885. That, moreover, despite the greatly increased traffic of the later period. As further proof of the progress made in locomotive, carriage and wagon materials and design, it may be said that whereas tire failures in this century have numbered 2381, there was practically the same number in 1891–1895 alone, whilst the failures of wheels have become so rare that they no longer have a heading in the returns. Failures of couplings, in the same periods, unfortunately, cannot be compared, owing to a change made, as from the end of 1906, in the method of reporting.

Surely we may claim that these are records of which engineers may be very justly proud. Yet, after all, *The Times*, in drawing attention to a few mishaps, is, perhaps quite unintentionally, paying a great compliment to the safety record of British railways. It is certain that in no other important country in the world would attention be directed to such mishaps as the separation of a coupling, the breakage of a wagon draw bar or the failure of an axle. The fact is that in this country accidents are so rare that minor casualties assume an importance that the event does not warrant. Equally certain is it that in no country in the world is there a greater density of traffic, and, consequently, so great a risk of accident, nor one in which there is such freedom from even trifling mishaps. Last year 346½ million train miles were run, and yet, as Colonel Sir John Pringle's recently issued annual report shows, it was found necessary to inquire into only twenty-two accidents—seventeen collisions and five derailments. In only two cases was the blame placed on the engine or rolling stock.

The French Motor Industry.

(By our own Correspondent in Paris.)

The interest of the Motor Car Show in Paris this year lies in what can be learned of the means whereby French makers hope to escape from the difficult situation in which most of them are placed. The prosperity of the industry in the past depended entirely upon the export trade, which attained particularly big proportions during the period of currency depreciation; but, as that depreciation was equivalent to a premium on exports, other countries were obliged to put up the import duties on motor cars in self defence, with the result that, when the franc appreciated to its present level of stabilisation, the cost of manufacture increased and cars could no longer be sold against the foreign import duties. The French motor car industry is, therefore, passing through a critical phase. The main hope of manufacturers is to develop the home demand sufficiently to provide work for the automobile factories. But whilst there is a steady increase in the number of cars employed in France, the rate of progression is not sufficient to absorb anything like the production of the home works. Makers, therefore, see that if they are to bring in new classes of buyers they must reduce their manufacturing costs and bring down selling prices which have not receded proportionately to the appreciated value of the franc. For more than a year past the policy of the French industry has aimed at a reorganisation with a view to economy of manufacture. An endeavour has been made to group a number of firms, each of which would undertake to build types of cars that did not compete with the others, and all of which would collaborate in the production of the cars and in the purchase of raw material. Each firm, nevertheless, would preserve its liberty and individuality. This attempt at mutual collaboration does not appear to have proved entirely successful, for it is reported that the first grouping of three important makers is imperilled by one of them withdrawing, and it is doubtful if the system will be carried through, although it is constantly affirmed that the prosperity of the industry depends upon some such combination. In Belgium arrangements have already been come to between Minerva and the Fabrique Nationale on the same basis. So long as all makers work independently of each other it is obviously difficult for the majority of them to pass successfully through what is really another period of automobile evolution. At the earlier Shows there were many attempts to depart from general practice. Those attempts always failed and for many years afterwards there was a uniformity that suggested finality; but the fact that the last Paris Show indicated a further outbreak of originality is evidence of the belief amongst a large section of the trade that some departure is necessary in order to infuse new vitality into an industry which is suffering from overproduction.

Whatever may be the fate of the many new devices presented at the Paris Show, it is certain that they respond to requirements of users. Yet many of them will fall into oblivion because they are carried too far. A low centre of gravity, for example, is desirable, but when the frame is below the axles the road clearance is so small as to constitute a danger; but at the Show there were probably half-a-dozen different vehicles with the frame a few inches from the road. The design has been inspired by accidents arising out of the high speeds at which motor cars are now driven, but if it introduces new dangers when passing over obstructions in the road it is better to find safety by other methods. One of the leading makers, Chenard and Walcker, showed a car of a type that was presented in various forms by a few other firms, thereby suggesting that the idea of a low roomy car is in the air and may be developed, if approved by the buying public. The frame is rectangular, having almost the full width over particularly wide track wheels. The plan of the body is rectangular, like the frame, the top sloping to the front, and the rear carries the engine and gear-box which form a unit with the differential. Its appearance is not attractive, whatever its advantages may be, and there is a great loss of space in the huge square engine bonnet behind. Another car of the same type is the Claveau, in which there is an air-cooled horizontal engine with opposed cylinders at the rear. The design of the cars is based upon ideas of theoretical perfection, and experience alone can show to what extent the confidence of their designers is justified. In any case French makers see that they must take the lead if they are to recover their position in the automobile industry. The big firms can only improve their existing types, but others feel that they must impose new ideas or disappear. In many cases it is possible that these ideas may suggest the way to future developments. In the suspension of chassis existing methods have accomplished all that can be expected of them, and with ample springs and shock absorbers the modern high-class car usually gives satisfaction. At the Paris Show the problem of suspension received special attention, and in some cases involved again somewhat cumbersome devices, usually a combination of transverse springs and voluminous spring or rubber dampers. In one chassis of rectangular form built up with large section tubes the wheels were carried on brackets pivoting on the tubes, each bracket engaging in a plunger in a long tubular dashpot with differential springs adjusted to meet shocks and vibrations. The rear wheels were driven by shafts with universal joints. Another revival of an old idea in a new form was the front-wheel drive with the crank chamber, variable speed gear and differential in one unit. This design provided another means for lowering the centre of gravity. It was seen in the Tracteur, Bucciali, and one or two other chassis. In some cases the spur wheel gear-box was replaced by infinitely variable gears, one of them being a mechanical development of the swash plate hydraulic gear, and another was claimed to be automatic in action. With probably one or two recent

exceptions the trouble with mechanical infinitely variable gears is that they are noisy, less efficient, and much heavier than the ordinary gear-box. The importance attached to mechanical solutions which represent departures from the customary automobile practice is a natural outcome of the desire of certain makers to find a way out of the difficulty caused by the lessened activity of the French motor car industry.

Motor car construction in France is influenced by the high cost of petrol, which necessitates a particularly close regard to economy of consumption. This involves the use of engines of small cylinder capacity and high angular velocities and the building of light chassis. In this direction the motor car appears to have reached a point beyond which it is impossible to make further appreciable headway. This striving after reduction of weight is mainly responsible for metallurgical progress. Nevertheless, despite the remarkable results obtained with the production of metals of particularly high tensile strength, some of the cars at the Paris Salon were built up with parts of such small section as to leave an impression that the weight was cut too fine, but in reality they are sufficiently strong and provide a fair margin of weight, which is acceptable when there is much to be gained in fuel consumption and tire maintenance. Nothing, however, can justify this sacrifice of weight except a careful selection of materials and perfect workmanship. This weight cutting is not carried to the same extent by firms which have a reputation for the solidity and durability of their cars. It is quite possible that there may be some reaction against a practice which may exceed the bounds of prudence.

In engines the general use of self-starters has permitted the employment of high compressions. Makers get everything out of the engine except a flexibility which will dispense with a too frequent changing of gears. It is here that British and American practice has influenced the French industry, as it has done on previous occasions, and the most striking feature of the Paris Show was the number of six and eight-cylinder engines, examples of which were shown by practically every leading maker. It is now deemed necessary to be able to start on top gear and accelerate on the level up to the maximum speed. It is in striving after this ideal that the automobile industry is undergoing another evolution. British and American six-cylinder cars have shown how such flexibility can be obtained, and the invasion of American vehicles, which were present at the Show in great strength, makes it clear to French manufacturers that they are unable to remain in a state of inferiority on any point affecting the comfort and convenience of users. Under the new tariff scale there can be little hope of American firms sending cars to France, but the prospect of a treaty of commerce being entered into with the United States leaves the way open to a formidable competition, although it is by no means certain that American cars, even if they could be sold more cheaply than French vehicles of corresponding grade, would find a large market in France, in view of the fact that makers on the other side of the Atlantic have not the same reasons for reducing the fuel consumption to a minimum as have those in Europe. Meanwhile, the prices at which French cars are now offered show a considerable reduction, and makers have displayed remarkable energy and perseverance in adapting their industry to changed conditions. The Paris Salon indicated that they are grappling with the problem of widening a market which, they hope, will absorb what is at present an over-production, but there is nothing yet to show to what extent they will succeed.

The 110th Anniversary of the John Cockerill Works.

Among the great engineering organisations of the world few can lay claim to a history as long and famous as that of the John Cockerill Company at Seraing. Founded in 1817, two years only after the Battle of Waterloo, its centenary fell due at a time when there was neither cause nor mood for rejoicing. Belgium was then under the heel of the German invaders, helplessly regarding, amongst other tribulations, the systematic pillage and destruction of her industrial plants and the deportation of her skilled workmen in accordance with a policy dictated presumably by certain German industrialists, who wished to be rid of competition in the future. As might be expected, the great Cockerill works suffered particularly badly. All the important equipment of the works, including five blast-furnaces, nine rolling mills, thousands of machines, and most of the locomotives, wagons, travelling cranes and electric motors were either destroyed on site or carried off into Germany. Buildings and even foundations were involved in the general ruin. With works practically razed to the ground and workmen and staff scattered far and wide, it looked, in 1917, as if a funeral dirge would be more appropriate for the firm than any celebration of its centenary. But neither the board of directors nor the general manager, Léon Greiner, were among the kind of people to sing dirges. They held rather to the proud motto "Courage to the last," which had so long formed part of the heraldic device of the John Cockerill Company, and no sooner had they regained possession of their ruined works than they set about the herculean task of reconstruction. This was pursued with such energy that, in spite of obstacles which might have well been considered insuperable, they have been able this year, not only to celebrate the 110th anniversary of the founding of the company, but to do it in one of the finest and best-equipped works in Europe, where one may look in vain for any trace of the ruins that it was in but nine short years ago.

The celebration took place on Saturday, October 1st, and the presence of H.M. King Albert, supported by Monsieur Jaspar, the Prime Minister, and many other Ministers of State and eminent public men, gave the event something of a national significance. A special train, drawn by a Cockerill-built locomotive, brought many of the guests, including the King, from Brussels to Seraing, and thence the party was conveyed to the works by the company's own carriages and yard locomotives. In the "Court of Honour" of the old château which forms the offices of the company the King was received by Monsieur Léon Greiner, and after several presentations and the laying by his Majesty of a wreath of flowers on the memorial to the employees who had fallen in the war, the party proceeded on a tour of inspection of the works. The arrangements for this reflected the greatest credit on all concerned. An hour and a half was allowed for the tour, and in that time the guests were conducted in turn through the machine shop, locomotive erecting shop, heavy erecting shop, heavy forge, power station, rolling mills, boiler shop and foundry, spending some time on the way in inspecting two of the blast-furnaces and the Bessemer basic steel plant. The shops and furnaces were everywhere in full operation, and, as if by chance, at every point one happened on some striking or typical demonstration of the capacity of the works. In the erecting shop, for example, one passed by steam turbines, turbo-blowers and a vertical marine engine of considerable size, all in an interesting stage of manufacture. In the heavy forge a 2500-ton steam-hydraulic press and a 2000-ton straight hydraulic press were both in action. As the party arrived at the blast-furnaces one of the furnaces was tapped and the metal run into pigs, while the metal from the other rose up from concealed gates into an open sand mould, and the greeting "VIVE LE ROI!" appeared in huge white-hot letters, surrounded soon by a blinding border of flowing metal. This, which was most excellently done, seemed to be the only arrangement specially made for the visit, but those who had had experience of conducting strangers round a works could appreciate the unseen organisation which assured that everybody saw everything he wanted to without hurry, nobody got lost or left behind, and members of the party arrived punctually and all together at the end. Even so carefully planned a tour could not, of course, do anything like justice to the resources or the activities of such an establishment as that of Cockerills, but the imagination was further assisted by exhibits in the yards. A full-sized replica of Le Belge, a locomotive constructed by Cockerills in 1835, and actually the first locomotive to be built on the Continent of Europe, was standing alongside one of the latest eight-coupled locomotives of the firm. A field gun also hinted at the production of material of war, and a 125-ton travelling jib crane, said to be the largest of its kind ever made, showed the facilities the firm possesses for handling its heavy products.

It may not be out of place at this point to endeavour to give an idea of the magnitude of the Cockerill Company. The Seraing works alone employ about 10,000 men and cover more than 360 acres. The company has its own coal mines in the neighbourhood, the concession extending to about 750 acres. It has seven blast-furnaces, with an aggregate capacity of 1500 tons of iron per day. Five batteries of coke ovens of the Semet-Solvay regenerative type, with by-product recovery plant, can produce 1300 tons of coke in the same time. Power for the works is derived from three central stations, equipped solely with Cockerill gas engines working on coke oven and blast-furnace gas. The aggregate capacity of the generating plant is 28,000 kW and 120 million kWh are absorbed annually in the works. Steel is manufactured by five basic converters of 15 tons capacity each, giving 1400 tons of steel in all per day. There are in addition four Martin furnaces, ranging from 15 to 25 tons, and two electric furnaces of 5 and 12 tons respectively. The blooming mill of the most modern type, with hydraulic manipulator, is driven by a 5000 H.P. reversible motor, capable of a maximum output of 16,500 H.P. Next to this is a 900 mm. reversible mill for sections up to joists of 600 mm. depth, a 600 mm. mill and two mills of 350 mm. and 250 mm. for merchant bars. In addition to these there is a 300 mm. mill for rolling special steels, a shop for making railway springs, another for railway tires, and plate rolling mills capable of dealing with material of almost any size and thickness. The forge is equipped for dealing with ingots up to 80 tons, for the production of such articles as gun tubes, marine crank shafts, armour plates, &c. The heavy forging presses have already been mentioned, and there are in addition steam hammers up to 10 tons. The foundries are probably the most impressive in the world, comprising a vast and perfectly lighted working area of over 340,000 square feet. Single castings weighing up to 120 tons can be made and handled, and an annual output of over 25,000 tons of castings is obtained.

In addition to the Seraing works, the Cockerill Company has a shipyard at Hoboken, near Antwerp, where all the turbine steamers serving the Dover-Ostend route were constructed, as well as the fine vessels for the Antwerp-Matadi service of the Compagnie Belge Maritime du Congo. For the needs of its own works and establishments the Cockerill Company operates between 50 and 60 miles of private railway, with fifty-one locomotives of their own construction and about 1000 wagons, including over a hundred 40-ton mineral wagons with automatic dumping. It should be added, finally, that few firms in the world do as much for their employees as the Cockerill Company, with the result that 25 per cent. of the workmen have been with the company for twenty years or more, and a considerable number can record a service of forty years. We have no space to write here of the hospital, dating from 1849, with its hundreds of beds and every modern apparatus and convenience, of the orphanage, of the school, of the support given to technical education, of the home for aged workers, of the arrangements by which more than one-tenth of the employees have been enabled to purchase their own homes, of the pension scheme under which the workmen can retire at the age of sixty or sixty-five years, or of the pecuniary assistance given by the firm to gymnastic, musical, fencing, literary, and many other societies interesting to their workmen. We have said enough, however, to give a slight sketch of the activities of the company, and may therefore return to the celebrations of the anniversary.

The tour of the works completed, guests to the number of several thousands assembled in the main foundry, measuring 90 m. by 70 m., which had been cleared and decorated for the occasion. On a platform erected in front of the cupolas was the King, supported by Messrs. Jaspar, Theunis, and other Ministers, and the whole of the directorate of the John Cockerill Company. Behind them, with a touch of symbolism, were placed the marble busts of the five chiefs, namely, John Cockerill, Gustave Pastor, Eugène Sadoine, Adolphe Greiner, and the present Mr. Léon Greiner, under whose successive direction for 110 years the works has reached their present magnitude. The proceedings were opened by the national air, "La Brabançonne," the King receiving an ovation such as his well-deserved popularity always ensures. The first speech was that of Monsieur Louis Chainaye, president of the board of directors of the company, who expressed the satisfaction felt that the King was present at a *fête* which was not only commemorative of the foundation of the company, but also of its reconstruction after the war. Monsieur Léon Greiner, the general manager, then gave an account of the development of the company from its earliest days.

The history of the John Cockerill Company may be said to have begun as far back as 1797, when William Cockerill, a Yorkshire mechanic, emigrated in search of work and arrived in Belgium from Sweden, accompanied by his three sons, William, James and John. The father started a little workshop at Liége to make carding engines for the woollen trade, and met with such success that he soon took larger premises in the same town. He was assisted by his sons, and especially by John Cockerill, who at that time was a lad of about eighteen years, and in 1813 he turned over the workshops altogether to John and his other son William. These young men rapidly developed the business, and in 1817 John had the courage to acquire from William I., the King of Holland, the "Chateau and Domain of the Princes-Evêques" at Seraing in accordance with a plan he had, not only of constructing carding engines, but steam engines of all kinds. His energy and ambition seem to have been equalled only by his ability, for in 1824 we find him no longer confining himself to the construction of engines and machines, but erecting the first blast-furnace in Belgium to be operated with coke, and soon afterwards acquiring a concession for working the coalfield which lay beneath his property. The development of railways afforded him a further opportunity for enterprise, and the Seraing works turned out the first rails for the first railway on the Continent, namely, the line from Brussels to Malines. It was in the same works that the first locomotive to be constructed on the Continent was built, namely, the engine called Le Belge, to which we have already referred. It is not too much to say that the history of the early development of engineering and the iron industry in Belgium is largely the history of the activities of John Cockerill, a man whose name ranks deservedly among those of the great engineers of the world.

At the death of John Cockerill in 1840 the management of the works passed to his nephew, Mr. Gustave Pastor, who had been associated with him since the age of sixteen years. The business was reorganised in the form of a company in 1842, with Mr. Pastor as managing director. The change in the form of proprietorship in no way changed the progressiveness of the undertaking, and under Mr. Pastor's management, in 1861, the company introduced the Bessemer process, again the first event of its kind on the Continent. In 1865, after half a century of active and successful work, he resigned the control of the works to Monsieur Eugène Sadoine, an ex-naval officer, who possessed in the highest degree the art of organisa-

tion and to whom is due the departmental organisation which exists to-day. Monsieur Sadoine was followed in 1887 by perhaps the most famous manager, after John Cockerill himself, which the works have ever known—Mr. Adolphe Greiner—who had previously been chief of the steel works department. The memory of Mr. Greiner's charming personality, his nobility of character, and his practical wisdom will be fresh in the minds of many of our readers. He was well known in England, and besides receiving an honorary Doctor's degree from the University of Leeds, he was awarded the coveted Bessemer Gold Medal of the Iron and Steel Institute, and was elected President of that Institute in 1913. Under his direction the Cockerill works were carried to a degree of prosperity undreamt of by their founder. The invasion of Belgium in 1914 and the pillage and destruction of his beloved works gave him a blow from which he never recovered, and he passed away in November, 1915, regretted and honoured by all who had known him. His son, Mr. Léon Greiner, who at that time was engineer-in-chief to the company, succeeded him as general manager. Mr. Léon Greiner was taken as prisoner to Germany almost directly after entering upon his new duties, and kept there, often threatened with death, till after the Armistice. The condition of the works to-day, risen Phœnix-like from their ashes in nine years at a cost of 200 million francs, is sufficient evidence of the manner in which Mr. Léon Greiner is carrying on the traditions of his great predecessors at Seraing.

The last of the speeches at the official celebration of the 110th anniversary of the firm was that of the King. He referred to the example set by the founder of the firm, and urged that the courage and energy shown by the Belgian people in the war should be applied intensively to the sciences and industries by which alone so small a nation could be prosperous. The celebration was concluded by a banquet, at which the King presided over 1400 guests, many of them being employees of the firm. After the banquet speeches were made by Monsieur Carlier, vice-chairman of the board of directors of the Cockerill Company; Monsieur Jaspar, the Prime Minister; and Monsieur Merlot, the Bourgmestre of the town of Seraing; the King and many of the guests subsequently returning to Brussels by a special train.

In the current issue of *Vulcan* there is a hint as to a trouble of a rather unexpected nature which may develop in the indication of heavy oil engines. It is explained in the following manner:—The hole provided for attaching the indicator to the cylinder, when not required, is usually closed by a screwed plug. This plug should be arranged so as to completely fill the hole for the full depth of the casting. The reason for this is shown by a recent experience of the writer when attempting to indicate a heavy oil engine. The plug in the breech end was removed overnight and replaced by an indicator tap. On arriving to indicate, the tap was opened to see the orifice was clear, but no gas was blown through. A wire passed through the tap suggested a "blind hole." The engine was therefore stopped, and the tap removed, when the bottom of the hole appeared to be so solid that heavy blows on a stiff punch were required to displace what proved to be a very hard plug of carbon which had formed below the end of the screwed plug and so effectually closed up the hole. It may be added that it was necessary to remove the exhaust valve to recover the carbon plug before starting up the engine again.

Motor Car Show at Olympia.

No. I.

In our introductory remarks regarding last year's motor car exhibition at Olympia we ventured to forecast that, for private vehicles, six-cylinder engines would in the near future be nearly as numerous as four-cylinder power units. Visitors to the Show which is now being held cannot fail to be impressed by the very marked increase in the number of cars so equipped. For this year rather more than one-third of the different types of British-made vehicles were fitted with six-cylinder engines, while in next year's models—as represented at the present Show—the proportion of six-cylinder units will be close upon 45 per cent. This remarkable growth would seem to indicate that by the time next year's Show comes round the six-cylinder car will be almost as common as that with only four cylinders. From a mechanical point of view this is probably the outstanding feature of the Show, but a really novel departure is the introduction of the free-wheel car. This is a very interesting application of the well-known free-wheel clutch of the bicycle as an adjunct to the transmission system of the car, without unduly complicating the control. The free-wheel mechanism is placed in the transmission system behind the gear-box, and is brought into play by the simple movement of a lever at the driver's left hand. We shall refer to this new departure at length later. In the meantime, it may be said that, in practice, with the free wheel in action, it is a simple matter to change from any gear to any other gear silently without using the main clutch, merely by decelerating the engine as the gear lever is moved. From actual experience obtained on a car fitted with this free wheel, we should be inclined to say that there is a promising future for such a device.

Another feature at this year's Show is the tendency on the part of several well-known car manufacturers to revert to the side-by-side valve engine. Although perhaps this type of engine is slightly less efficient than the overhead valve engine, there is a decided gain in simplicity. Compression ratios are slightly higher than formerly, and supercharging or forced induction has been brought into prominence as the result of increased reliability which has been gained by experience in sporting contests. It is interesting to note that at least one British firm is exhibiting a standard supercharged car. Whether the increased power obtained by the fitting of a supercharger will compensate for the additional complication, is a moot point; nor should it be lost sight of that higher working pressures, which the supercharger involves, demand greater strength of the working parts of the engine, such as the pistons.

A real objection which makers of superchargers have still to overcome is that of noise, which is all the more pronounced as engines become quieter in operation. With the ever-increasing number of cars which are annually coming on to the roads, the question of noise is one of extreme importance, and drastic steps are now being taken with the object of enforcing better silencing arrangements.

In methods of transmitting the power of the engine to the road wheels, there is little of novelty to be seen, but it will not escape notice that one very well-known firm which has hitherto adhered tenaciously to the cone clutch with a fibrous covering has at last come into line with the more advanced practice, and is now using a clutch of the metal plate pattern. Gear-boxes which have been considerably quietened

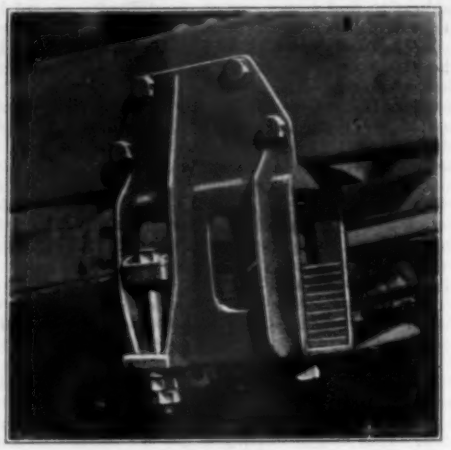


FIG. 3—SPRING BRACKET—BEAN

by the introduction of ground teeth, remain substantially unaltered, and the four-speed gear-box is slightly gaining in popularity over the three-speed box. While the magneto still predominates, it is noticeable that several of the new models are fitted with coil and battery ignition. A few years ago the six-cylinder type British magneto was not entirely above reproach, the stresses involved by the increased number of cylinders seemed to be the cause of frequent internal troubles. Present-day instruments, however, are greatly improved in this respect, and it is truly remarkable how few cases of ignition trouble are traceable to the magneto. Still, there are a select few car builders who make doubly sure by fitting a dual system of magneto and coil, but out

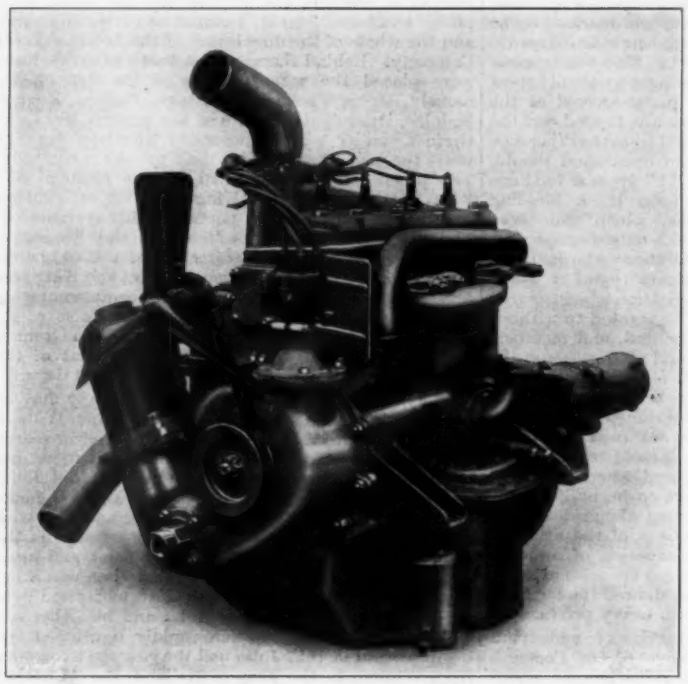


FIG. 1—ENGINE OF 14-40 H.P. BEAN CAR

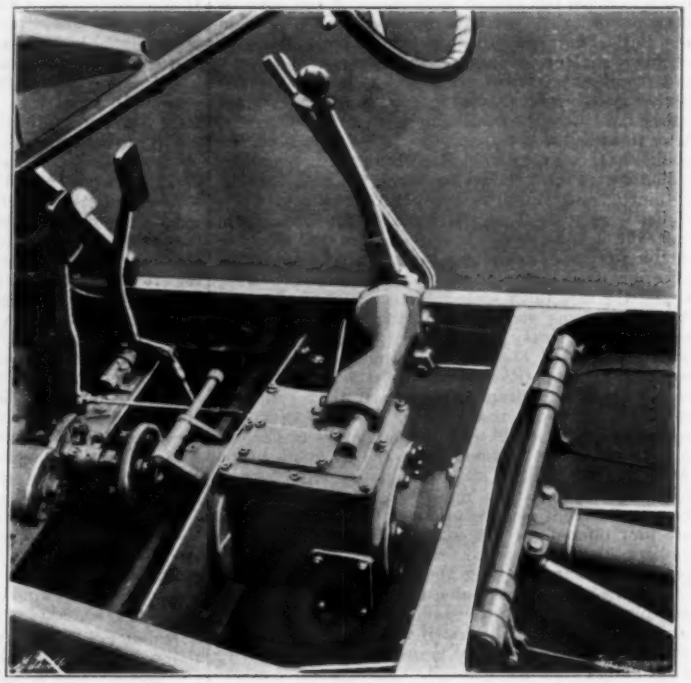


FIG. 2—GEAR-BOX OF 14-40 H.P. BEAN CAR

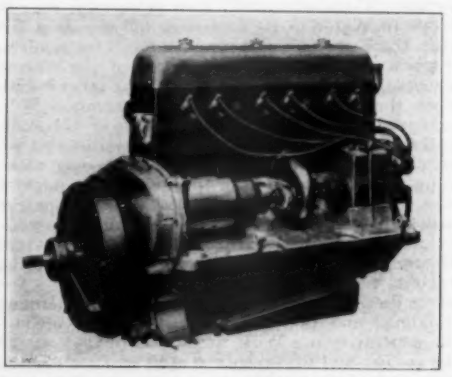


FIG. 4—14-75 H.P. ALVIS ENGINE

of the many thousand cars in almost daily use in these islands probably not 5 per cent. are thus provided.

Perhaps the greatest advance which is observable in next year's cars is in connection with the coach-builders' craft. The totally enclosed car has made tremendous strides during the last year. The climatic

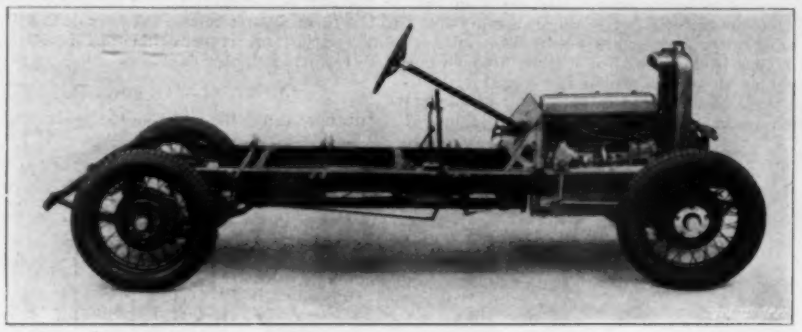


FIG. 5—14-75 H.P. ALVIS CHASSIS

conditions which have to be contended with in this country furnish ample reason for this development, but the coming year will witness a tendency on the part of designers to produce such bodies with removable roofs, so that a better view can be obtained by the passengers in the rear seats of the surrounding country when the sun does shine. The fabric body has come successfully through the testing period, including that of the wettest year in living memory, and its adoption is becoming much more general on account of its extreme lightness, freedom from internal noises, durability and easiness to clean. One of the early difficulties connected with the fabric body was the provision of metal fittings, such as hinges and latches of efficient construction. It has been largely overcome and little fault can now be found in that respect.

During the last twelve months the dashboard has become a pleasure to look at. In nearly all cases the various instruments thereon have been neatly grouped together at the centre of the facia board and efficiently illuminated from the rear for night driving. Better visibility has been afforded by the almost universal adoption of the single-pane windscreen. With the idea of increasing the driver's comfort, two car builders have considerably increased the rake of the steering column, thereby bringing the steering wheel nearer to the vertical plane. This, together with an adjustable telescopic steering column, should add very greatly to the comfort of the driver. For the safety of the road-travelling public, it is to be hoped that steps will be taken to enforce the fitting of head-lamp dimmers or dippers to every new car. An effective and neat head-lamp dipping device by Lucas is exhibited, in which the reflectors are moved by pneumatic power from the steering column.

Before long the familiar red triangle mounted on the rear mud guards will be unnecessary, as all modern cars will be fitted with brakes on all four wheels as a matter of necessity. In some cases their operation is assisted by pneumatic power obtained through the medium of the induction system.

There are altogether 516 stands in the exhibition, and 100 of them are devoted to cars made in Great Britain, France, America, Canada, Italy, Belgium, Spain and Germany.

14–40 Horse-power Bean.

A new production which is creating much interest is the 14–40 horse-power Bean car. This vehicle has been designed as a "go anywhere" car, suitable equally for the home or overseas market. It is a moderate-priced vehicle, which is furnished with a four-speed gear-box and is capable of high speeds. The accessibility of the various parts on this model is worthy of note, for it leaves little to be desired. The engine has a bore and stroke of 75 mm. by 130 mm. respectively giving a total capacity of 2297 c.c., and a Treasury rating of £14. The cylinders and top half of the crank case are cast *en bloc*, and are attached to the frame by means of four supporting arms. The crank shaft is carried in three die-cast white-metal bearings. The connecting-rods are made of duralumin, and the pistons, which are of aluminium, have four rings and a split skirt to obviate piston slap. Side interchangeable valves are employed. The cylinder head is detachable and incorporates the Ricardo type of combustion chamber. Cooling is effected by a thermo-syphon, assisted by a belt-driven three-bladed fan, carried in an adjustable bracket at the front of the engine.

The cam shaft is driven by the crank shaft through helical gears. A submerged gear-driven pump, arranged in the sump, forces oil to all the bearings and engine gearing at a pressure of 40 lb. per square inch. A large oil filler and a breather are conveniently placed at the rear of the engine on the near side, together with a float-operated oil level indicator. Delco Remy coil and battery ignition is used, and the distributor together with the dynamo are driven by spiral gears from the cam shaft and crank shaft respectively—Fig. 1. Tappet adjustment is rendered easily accessible by carrying the inlet and exhaust manifolds as high as possible and fitting the Solex carburetter on the opposite side, thereby leaving the cover plates over the valve gear entirely unobstructed. The drive is taken through a single plate clutch and two flexible disc joints to the gear-box.

The arrangement of the gear-box and transmission is unusual. Across the middle of the frame—Fig. 2—is a stout channel-section cross member, and bolted to it are the two halves of the casing of the spherical universal joint. The rear half of the casing is attached to the torque tube and the front half to the gear-box, so as to ensure correct alignment of the gear-box and rear axle. Another cross member supports the gear-box at the front end, thereby maintaining its alignment with the engine. The four-speed and

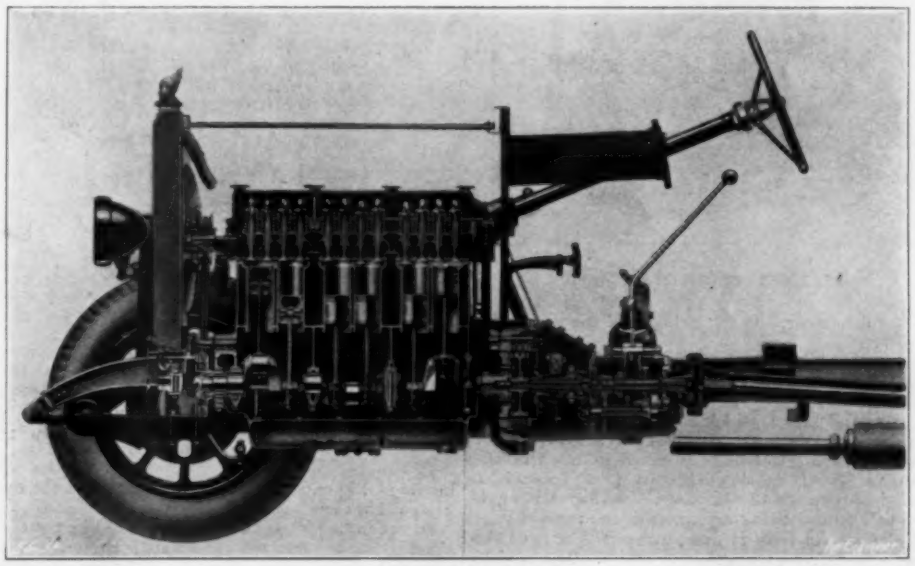


FIG. 7—SECTIONAL ELEVATION OF ENGINE AND GEAR-BOX OF 6-CYLINDER HOVER

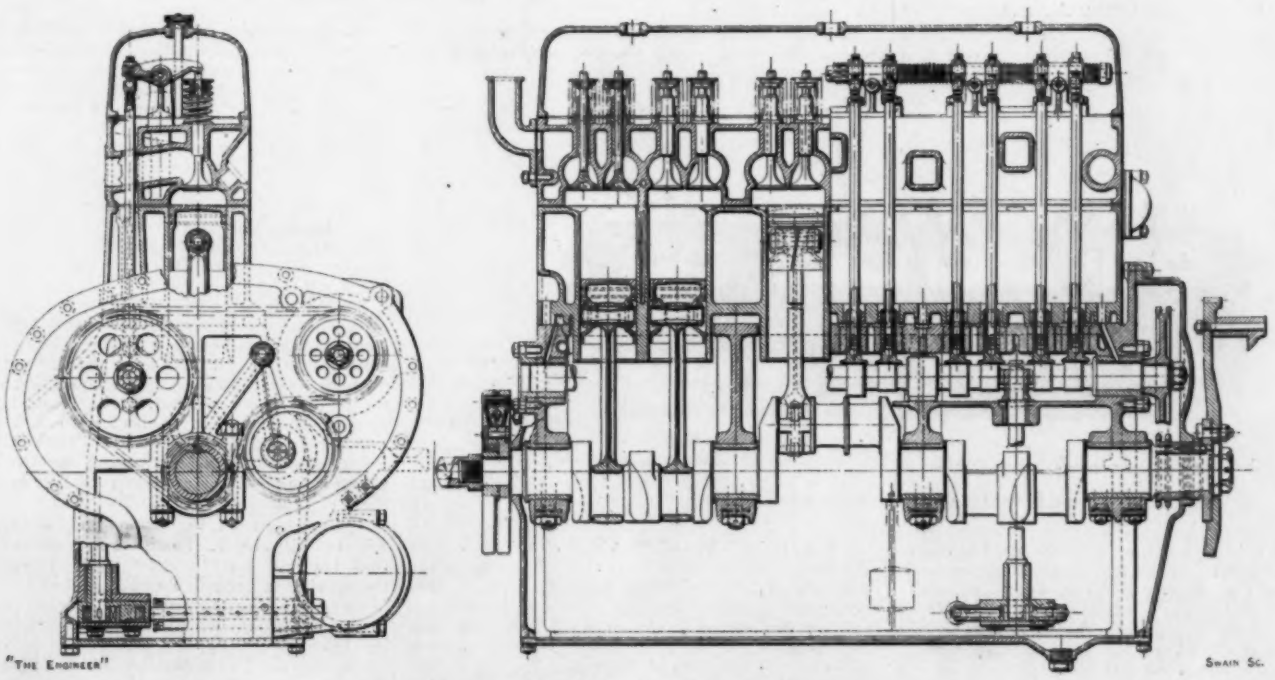


FIG. 6—14-75 H.P. ALVIS ENGINE

reverse gear-box, which provides the following ratios —18·15, 10, 7·3 and 4·4 to 1 on top, is fitted with right-hand control. The spherical universal joint is automatically lubricated from the gear-box. The speedometer and screen wiper drives are taken from the rear of the gear-box, and a facing is provided for the fitting of a mechanical tire pump.

The rear axle is of the three-quarter floating type, with an overhead worm drive, and is fitted with taper roller bearings throughout. The frame is of strong construction; it has channel section side members and channel section cross members, there being a double cross member adjacent to the rear spring brackets. Half elliptic springs are used on the front axle and quarter elliptic at the rear, the fixing of the latter being unusual. The butt ends of the quarter elliptic springs are secured in stout box brackets, depended from the side members of the frame, low enough to bring the springs into a practically horizontal position, as illustrated in Fig. 3. The butt end of the spring is then clamped downwards by a central pin at the front end and by a bridle clamp at the other end, thereby holding the bottom or master leaf in a

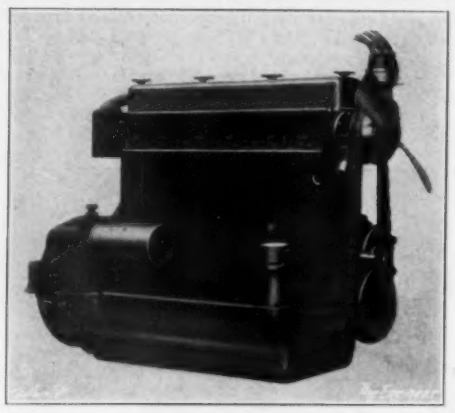


FIG. 8—ROVER ENGINE—STARTER SIDE

very rigid manner. The steering is of the worm and sector type.

Four wheel brakes of the internal expanding pattern are fitted, those on the front wheels being of the Perrot servo type. The foot pedal operates on all four wheels, but the hand brake, which is mounted on the right-hand side, acts on the rear wheels only. The radiator is fitted with a steel netting guard in front of the tubes. A 12-volt lighting and starting set by Smiths, which incorporates the single-pole wiring system, is provided, a fuse being arranged in each circuit. A 10-gallon petrol tank is fixed across the rear of the frame and secured by means of straps. The feed to the carburetter is by Autovac.

Six types of bodywork are fitted to this chassis, while all models are equipped with single-panel windscreens and cellulose finish is standardised. The six-cylinder 18–50 horse-power model introduced last year and exhibited by this firm remains practically unaltered.

14–75 Horse-power Alvis.

An important newcomer in the six-cylinder class is the 14–75 horse-power Alvis. This car, illustrated in Figs. 4 and 5, is intended not only to give a performance similar to that of the four-cylinder model made by this firm with regard to speed, but to possess a wider range of flexibility on top gear coupled with a greater degree of silence. The cylinders have a bore and stroke of 63 mm. by 100 mm. respectively, which gives a cubic capacity of 1870 c.c. and a Treasury rating of £15. The engine, which is of the monobloc pattern, has a detachable head that incorporates oval-shaped combustion chambers. The valves, which are push-rod operated, are placed in a straight line along the centre of the combustion chambers, the sparking plugs entering the latter diagonally.

The proportioning of the water spaces in the detachable head is interesting and is shown in Fig. 6. The gasket between the detachable head and the cylinder block is not used to make any water joint, an exterior passage being provided at the rear of the engine to connect the water space in the head with that of the cylinder jacket. Bolted to the cylinder block is a deep aluminium crank case carrying the crank shaft in four bearings. Duralumin connecting-rods with aluminium pistons are used. The bottom of the crank case is closed with a shallow detachable sump, the whole surface of which is covered with a gauze filter tray. Submerged in the sump is a gear pump, which feeds oil under pressure to the main bearings, big ends, cam shaft bearings and the overhead valve rocker gear.

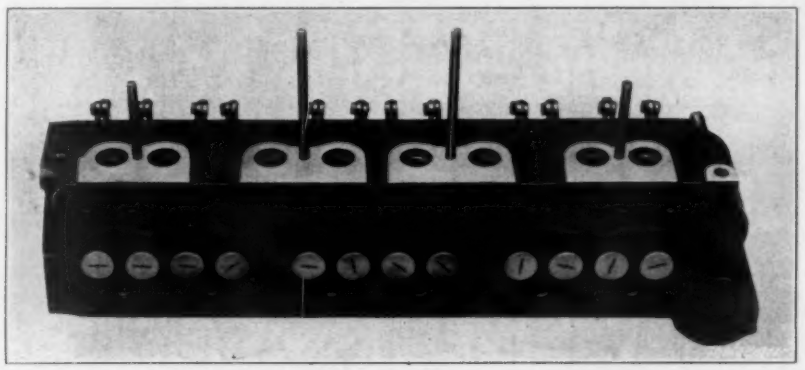


FIG. 9—DETACHABLE CYLINDER HEAD—ROVER

In order to reduce the torsional whip in the crank shaft to a minimum the cam shaft is driven from the rear end of the crank shaft by a duplex chain in a triangular drive, the dynamo also being driven by this chain. This drive is rendered self-adjusting by an automatic chain tensioning device, as shown in Fig. 6. The crank shaft is machined all over and a vibration damper is fitted at its front end. A straight-line drive is employed for the auxiliaries, the dynamo, water pump, and magneto being coupled together on the offside of the engine.

The inlet and exhaust manifolds are situated on the near side of the engine, the inlet ports being united into three pairs. The mixture is provided by a Solex carburetter, the outlet of which passes through a hot spot embraced by the ribbed exhaust manifold. The carburetter is fed by gravity from a 9-gallon petrol tank accommodated in the dash. The oil filler and float-operated oil level indicator are conveniently placed on the near side of the engine.

Behind the engine the chassis is practically the same as that of the four-cylinder model. The engine, which is a separate unit from the gear-box, is attached to a sub-frame pressed out of the main frame side members, and rests on four conical rubber buffers on each side. The drive is taken through a single-plate clutch to a right-hand-controlled four-speed gear-box, and the final drive is through a spiral bevel rear axle. The suspension is by semi-elliptic springs, front and rear, assisted by shock absorbers. Four-wheel brakes of the internal expanding type are fitted, the brakes on all wheels being operated by the foot pedal, the hand lever acting upon the rear wheels only. Dipping headlights, which are part of the standard equipment of the car, are operated by a centrally placed lever in the front compartment. A 12-volt C.A.V. lighting and starting set is provided and ignition is by a B.T.H. Polar inductor magneto.

2-Litre Six-cylinder Rover.

Another interesting addition to the six-cylinder class is the 2-litre car exhibited by the Rover Company, in addition to its two four-cylinder models. This new car possesses several noteworthy features, as will be observed from the illustrations, Figs. 7, 8, 9, and 10. The engine has a bore and stroke of 65 mm. by 101·5 mm. respectively, giving a total capacity of 2023 c.c. and a Treasury rating of £16. The cylinders and top half of the crank case are cast *en bloc*, embodying the four bearings for the crank shaft and cam shaft. The valves are of the orthodox overhead type operated by push rods from the cam shaft, the latter being driven by a silent chain from the rear end of the crank shaft.

The construction of the detachable cylinder head is unusual, in that the combustion chambers are formed in the cylinder barrels, and the underside of the cylinder head is flat, the sparking plug holes protruding angularly into the combustion chambers. Aluminium pistons having two rings in the head and a scraper in the skirt are employed. Ignition is by battery and coil, the distributor being driven through a long vertical shaft by skew gears, from the front end of the cam shaft. The distributor is in a readily accessible position at the front of the engine on the near side and also on the same level as the valve cover. The manner in which the power unit is carried in the frame is novel.

Three-point suspension is adopted, the single point at the front end consisting of a short beam screwed into the front end of the cylinder crank case casting and supported on a plate attached to the front cross member of the chassis. A flexible mounting is provided for the unit at the rear end, two extension arms on the fly-wheel housing are connected to stiff laminated four-leaf springs bent to fit round the outside of the chassis members. A bolt passing through both ends of the spring and holding the extension arm between them completes the flexible mounting.

The lubrication is by means of a gear type pump—Fig. 10—situated in the aluminium sump and driven from the cam shaft by skew gears. From the pump the oil is forced through a filter bolted to the outside of the crank case, and easily removable for cleaning, to the cam shaft and crank shaft bearings. The big end bearings are supplied with oil through the drilled crank shaft. Following the latest Rover practice, the engine, clutch and gear-box are lubricated by a common system, oil being forced down the hollow crank shaft through the hollow clutch shaft and into the main shaft of the gear-box, where a constant level is maintained, the overflow being returned to the sump. No less than three gallons of oil are continually circulated in this system, the sump alone holding

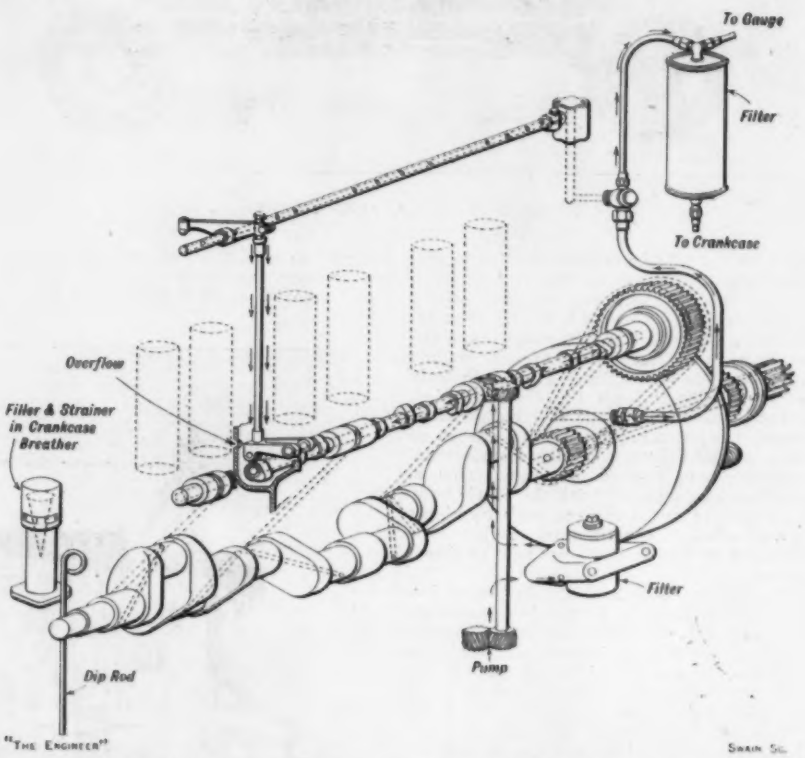


FIG. 10—OIL PUMP AND LUBRICATING ARRANGEMENT—ROVER

two gallons. Oil is also taken from the rear end of the crank shaft to the cam shaft drive and by an external pipe to the hollow rocker shaft, a certain amount of this oil being by-passed to a cannister type of oil filter situated on the front of the dashboard. This filter is of a common type and is not cleanable, but is intended to be renewed about every 12,000 miles. The ball cup joints at the top of the push rods are supplied with oil by channels cut in the rockers, the latter being supplied from the hollow rocker shaft.

Cooling is by an impeller type pump housed in the forward end of the cylinder head and driven by Whittle belt from a pulley situated at the front end of the crank shaft. This pulley also houses a Lanchester vibration damper. Actually there is no water connection to the cylinder block, the top connection to the radiator being taken from the thermostat arranged at the rear end of the cylinder head. The inlet and exhaust manifolds are situated on the near side and so arranged as to heat the ingoing charge from the twin Zenith carburetters, the latter being fed by a vacuum tank from a 12-gallon tank at the rear of the chassis.

The clutch and centrally controlled gear-box form a unit with the engine. The clutch is of the cork-inset pattern, having three separate aluminium plates running in oil. Auxiliary springs are interposed between the plates to ensure disengagement of the free members when the oil is cold. From a cross pin type of universal joint at the rear of the gear-box the drive is taken through an enclosed propeller shaft, having a centre bearing to a spiral bevel rear axle. The arrangement of the worm and segment steering gear is uncommon. A bracket carrying a vertical shaft is bolted to the off side of the crank case, the steering box being situated at the top of the shaft and the drop arm, to which the drag link is attached in the normal manner, at the bottom. In this arrangement the drop arm moves in a horizontal instead of a vertical plane as is usual. This construction provides a well-raked steering column, thus giving a comfortable driving position.

The chassis frame is of normal construction, being parallel at the front and rear and tapering amidships. It has four cross members and is braced by diagonal members running from the centre cross member to the forward points of attachment of the rear springs. Semi-elliptic springs are used front and rear, the ends of the second leaves being carried round the eyes of the shackles. Shock absorbers are fitted all round. The front axle is of circular section and brakes are fitted to all four wheels. The foot pedal operates on shoes within all four wheels and the centrally placed hand lever on those in the rear wheels only. The four-wheel brakes are provided with an accessible master adjustment. A 12-volt Lucas starting and lighting equipment is fitted. The starter is accessibly placed on the off side of the engine and is carried in a housing integral with the crank case. Three types of body work are fitted to this chassis.

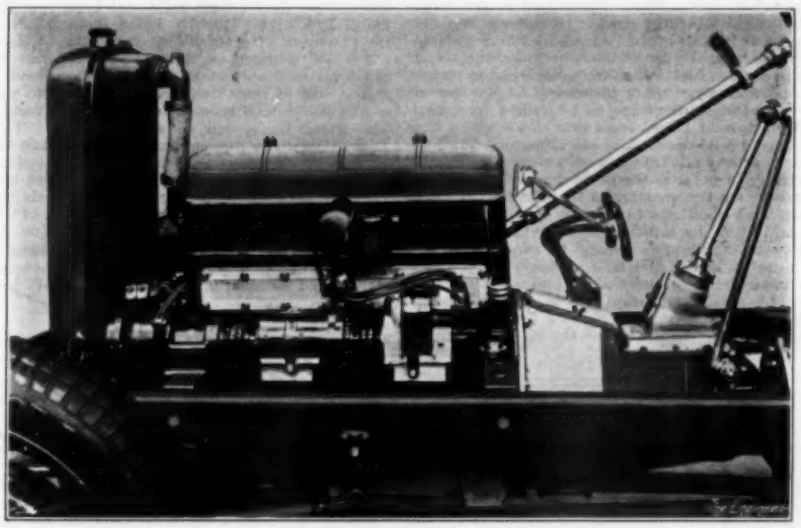


FIG. 11—ENGINE OF 18-50 H.P. STAR

18–50 STAR.

The 18–50 horse-power six-cylinder car shown by the Star Engineering Company, Ltd., see Fig. 11, is a new model which is being manufactured, in addition to the 20 horse-power six-cylinder and 12–40 horse-power four-cylinder models. The engine has a bore and stroke of 69 mm. and 110 mm. respectively, giving a total capacity of 2470 c.c. and a Treasury rating of £18. The cylinder block and the top half of the crank case are cast *en bloc*, and provide seven bearings for the crank shaft and cam shaft. The construction of the cylinder block is unusual, in so much as it is cast minus cylinders, the latter being separate centrifugally-cast iron liners machined all over and honed on the inner surface. These liners, which are illustrated in Fig. 14, are pressed into the cylinder block, and two square section rubber rings coated with rubber solution are fitted in grooves in the outer diameter of the liner at the bottom, the heat of the engine vulcanising the rubber solution and making a perfect joint. This arrangement is intended to give an even distribution of heat and reduce distortion to a minimum.

Duralumin connecting-rods and split-skirt aluminium pistons are employed, the latter being finally machined with a diamond tool. The distribution drive is by helical gear, the cam shaft pinion meshing with two other pinions, one on the end of the crank shaft and the other driving the water pump, dynamo and the Watford magneto. The construction of the lower half of the crank case is interesting. To ensure rigidity the top portion of the base is made of cast iron and bolted to the bottom flange of the cylinder crank case casting. The bottom portion of the base forming the sump is of aluminium. Lubrication is by means of a plunger type pump, the body of which is bolted to the cast iron top half of the sump, and operated by an excentric from the cam shaft. From the pump the oil is forced through a pressure filter accessibly housed in the near side rear engine arm, and thence to the main bearings and big ends, the latter being supplied through the drilled crank shaft; the oil being conducted entirely through drilled passages in the block, all oil pipes are eliminated, with the exception of that to the overhead valve gear. A Solex carburetter is bolted to the near side of the cylinder head and is supplied from a 10-gallon petrol tank situated at the rear of the chassis by Autovac.

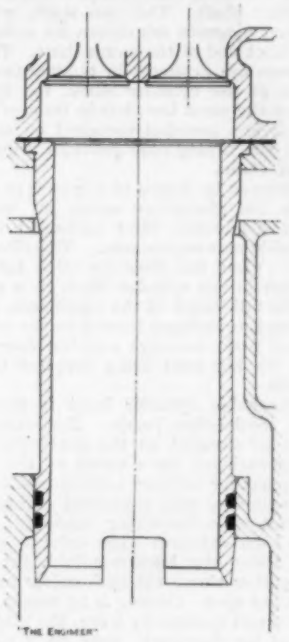
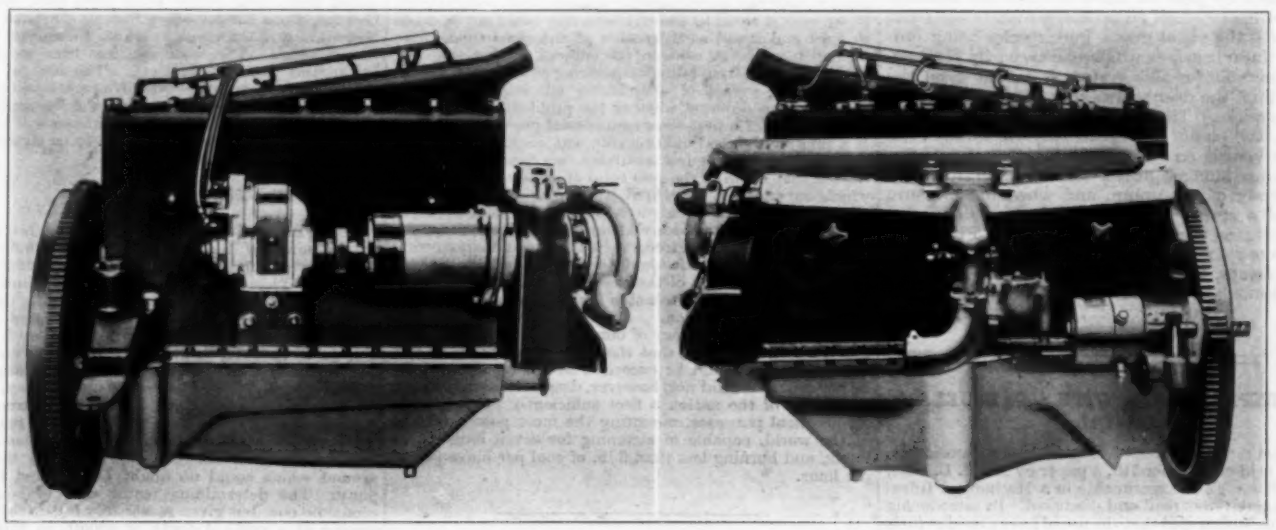


FIG. 14—LINER ARRANGEMENT—STAR

A vibration damper, fitted to the forward end of the crank shaft, consists of two plates, sprung apart, the outer surfaces being in contact with fibre friction rings. The drive is taken through a single-plate clutch to the four-speed centrally controlled gear-box. The gear-box is formed in one with the clutch housing, and bolted to a circular flange formed on the crank case. The ratios are 4·4, 6·78, 10·15 and 18·21. The drive is transmitted to the spiral bevel rear axle through a tubular propeller shaft having fabric universal joints at both front and rear. Semi-elliptic springs are used, both front and rear, assisted by shock aborbers. Steering is by worm and complete wheel.

Four-wheel brakes under Lanchester patents are fitted, the pedal applying internal expanding shoes within 12in. diameter drums on all four wheels. The centrally placed hand lever acts on two extra expanding shoes in the rear wheels only. A 12-volt lighting and starting set by Lucas is provided.



FIGS. 12 AND 13—MAGNETO AND CARBURETTER SIDES OF 6-CYLINDER 15 H.P. ARMSTRONG-SIDDELEY ENGINE

15 H.P. SIX-CYLINDER ARMSTRONG-SIDDELEY.

In view of the apparent supremacy of the overhead

valve position on motor car engines, it is interesting to find that the new 15 horse-power Armstrong-Siddeley vehicle is provided with side valves, especially when the vast experience this firm has had with six-cylinder engines of the overhead valve type is taken into consideration. The engine of the 15 h.p. six-cylinder Armstrong—Figs. 12 and 13—has a bore and stroke of 63·5 mm. by 101 mm. respectively giving a capacity of 1900 c.c., and a Treasury rating of £15. The cylinder block is cast integral with the top half of the crank case, and provides four bearings for the crank shaft. The cam shaft, water pump, dynamo and magneto are driven by a duplex chain from the front end of the crank shaft. The dynamo and magneto are arranged in tandem fashion along the offside of the cylinder block, the water pump being along the same line, but in front of the timing case. A jockey sprocket mounted on an excentric spindle in the timing case provides adjustment for the duplex chain.

Lubrication is by means of a gear type pump submerged in the aluminium sump, oil being forced through a detachable filter contained in a recess in the off-side rear engine arm. This filter is readily accessible. From the filter the oil is fed through a passage cast in the cylinder block to a gallery pipe running the full length of the crank case, from which it flows through passages formed in the webs to each of the four main bearings and the four cam shaft bearings, the big ends being supplied through the crank shaft.

The detachable cylinder head is provided with machined combustion heads. The cam shaft and valve gear are situated on the near side, the tappet gear being enclosed by a cover in the usual way. Separate ports for mixture and exhaust are provided on each cylinder, and a vertical carburetter feeds the mixture to a branching manifold, having an outlet to each cylinder. The exhaust manifold is mounted above the inlet manifold, the two being bolted together above the carburetter branch, so as to form a hot spot. Cooling is by means of a centrifugal pump and assisted by a fan, the blades of which are part of the fly-wheel. Ignition is effected by a B.T.H. magneto in conjunction with an automatic ignition control device, which eliminates the ordinary hand-operated lever.

Apart from the power unit the chassis is identical with that of the existing 14 horse-power four-cylinder car made by this firm, the drive being taken through a single plate clutch to a centrally controlled 3-speed gear-box, and thence to a spiral bevel rear axle. Internally-expanding four-wheel brakes are fitted, and semi-elliptic springs are employed, both front and rear.

An important addition to all Armstrong-Siddeley cars is that of central chassis lubrication, this firm being one of the first in this country to include that arrangement in its standard equipment. Central lubrication is an expression used to describe a method of lubricating all the important bearings in the chassis from an easily operated centralised pump. Many of these important chassis bearings are situated in most inaccessible positions, and, as a result, receive very little attention. The Armstrong-Siddeley method is to connect by pipe all these inaccessible bearings with a foot-operated oil pump carried under the front floor boards, the usual grease gun nipples being provided for those bearings which can be easily reached. The oil reservoir for this system is mounted on the engine side of the dashboard, and has a capacity of about two pints. The oil is fed through a filter to the pump, the plunger of which projects through the front floor-boards on the near side. The depression of the pump plunger draws oil from the reservoir into the body of the pump, and when the pressure is released a spring returns the plunger, delivering oil in turn to each of the separate pipes. Five pipes are connected to the pump, and serve to lubricate sixteen bearings, the supply being regulated by a jet fitted to each bearing.

(To be continued.)

SOME EXPERIMENTS WITH VENEZUELAN FUEL OIL.

At a meeting of the Diesel Engine Users Association, which was held on October 7th, a paper by Mr. E. L. Bass, entitled "Some Fuel Experiments in a Mechanical Injection Oil Engine," was read and discussed. In introducing the paper the author said that the use of heavy residue fuels in oil engines was of paramount importance to those responsible for their operation. In practically all parts of the world there was an appreciable difference in cost between residue fuels and distillates, and in some localities the disparity in cost was so great as to prohibit the use of distillates in oil engines for economical running. Fortunately in this country that position did not obtain, but the fact was not altered that for world-wide adaptability oil engines required development in the direction of increasing their fuel range without adding materially to cost or mechanical complication.

The engine on which the particular experiments referred to in the paper were carried out was a 32 B.H.P. cold-starting engine of the Crossley type working on the four-stroke cycle. It was belt coupled to a dynamo, the efficiency of which had been previously determined. The energy output of the engine was absorbed by resistances, the load being controlled by means of a field rheostat.

One of the chief physical characteristics of fuels which controlled their suitability for use on heavy-oil engines was Mr. Bass stated, their viscosity. The use of highly viscous fuels of necessity involved their preheating, so that the viscosity was reduced sufficiently to allow the fuel pumps and atomisers to work efficiently. In the experiments described in the paper two heaters were employed, one on the suction side of the fuel pump and the other between the fuel pump and the atomiser. The suction heater was a conventional form of exhaust heater with a deflector valve to control the amount of heat passing to the fuel container. The second heater was of the "Vicol" type and consisted of a rectangular piece of metal 8in. by 2¼in. wide and 1¾in. deep, through which a 1in. hole was bored for the passage of the fuel. The heater was bolted on to a flat face on the exhaust pipe. The author described a series of experiments he made when using these heaters and running the engine on various blends of Venezuelan residual oils with gas oils. Combustion pressures and fuel consumption curves were reproduced in the paper along with typical indicator cards. Reference was also made to the erosive effect of the fuels on the valve seatings.

In connection with the use of the centrifuge, the author found that in cases of fuels which were abnormal in respect of their proportion or nature of suspended foreign matter, there was a material advantage to be gained by centrifuging. With normal Diesel fuels and those which contained even up to 0·05 per cent. of ash there was, however, no evidence that any advantage would accrue by the use of the centrifuge in so far as the performance of the engine was concerned. On the question of the blending of heavy residue fuels with distillates for use on heavy-oil engines, Mr. Bass said that the limiting factor which controlled the quantity of distillate necessary to produce a commercially suitable Diesel fuel from a heavy residue was that point at which the viscosity of the fuel was sufficiently reduced to give good combustion over a wide load range, and yet did not require preheating to a temperature too close to that at which vapour locks in the fuel system might occur.

SIXTY YEARS AGO.

The practice of building warships elsewhere than in Government dockyards was, as we stated a fortnight ago, sufficiently novel in the 'sixties to provide ground for much discussion and criticism. The private builders, as we have already recorded, found themselves in considerable difficulties when first they entered into contracts with the Admiralty, for having had previous experience only in the building of mercantile vessels, they generally underestimated the cost of constructing a warship, and in most cases had to seek supplementary payments. From our issue of October 11th, 1867, we learn that, on the technical as well as the commercial side, warship building in those days was found to present difficulties which apparently were not encountered in the building of merchant ships. The warships of this country and all other Naval Powers, it was asserted, manifested as sea boats peculiar defects when compared with vessels of the mercantile marine. We had few warships, we said, that could compete with the Scotia in speed, and there was not one which could make the run to America in ten days, like the Cunard liners, whatever her speed. Passenger steamers went to sea without hesitation in gales which sufficed to keep our ironclads in harbour. Liners such as the Taeping or the Fiery Cross encountered storms without the loss of a spar, which sent our warships into port for a refit. The performance of our ships of war was only too frequently, in brief, of a kind to disgust the skipper of the smallest ship that found its way round the Cape of Good Hope with a cargo of tea or silk. Our fleets spent the major portion of their existence in port, and when they went to sea commonly made the worst possible passage from port to port. If, we said, it could be shown that a ship could not be made to fight and stand hard weather at the same time, there was no more to be said on the subject, except that our choice would have to fall upon securing efficiency in action, even to the extent of abandoning efficiency in a gale. We, however, doubted whether the problem of combining the qualities of a first-class commercial packet with those of a thoroughly good fighting ship was insoluble. Analysing the facts and figures available, we came to the conclusion that much of the sum total of disadvantages under which our warships laboured was to be assigned to the efforts made by their designers to secure great manœuvrability. We had not yet learned how to combine manœuvrability with speed. Indeed, to secure good manœuvring qualities current practice had no resort available, except to shorten the length of the vessel, a step which directly reduced the speed attainable and restricted the fuel storage accommodation. Something, too, could be ascribed to the inefficiency of our warship engines. It was not uncommon to find that the coal consumption on the measured mile would be exceeded at sea by as much as 50 per cent. We did not, however, despair of seeing in the possession of the nation a fleet sufficiently protected for all practical purposes, mounting the most powerful guns in the world, capable of steaming for seven days at 14 knots, and burning less than 2 lb. of coal per horse-power per hour.

South African Engineering Notes.

Municipal Undertakings.

A number of electrical and water undertakings are being contemplated by various municipalities, though no very large works have as yet been sanctioned. The town of Uitenhage has succeeded in securing the electric power load for the local railway workshops. There was keen competition with the Port Elizabeth municipality, but the Uitenhage offer was accepted on price. Plans will now be prepared for a new power station, which will probably start with two 1600 kW turbo-generator sets supplied with steam by mechanically fired boilers. Uitenhage is also considering the Groendal water scheme, which is estimated to cost £145,000, and it is recommended that a comprehensive loan should be raised to cover both power and water. The ratepayers of Mafeking have voted for a loan of about £11,000 for electric light extension, water boring, and the purchase of a deep well pump. The present capacity only amounts to 80 kW plus the battery. When it was installed the consulting engineer estimated that the whole output at the end of the third year would amount to 90,000 units per annum, whereas at the end of the second year it is 109,000, and with consumption continually increasing it is anticipated that the demand will be considerably more than doubled very shortly. The railway has applied for a minimum of 150,000 units per annum, and a new creamery is likely to be a good customer, being prepared to guarantee to take not less than 36,000 units per annum. It is proposed to install an additional 110 kW. A scheme to supply the township of Alberton with electric light has been prepared and submitted to the Electricity Supply Commission. A bulk supply would be taken from the Victoria Falls and Transvaal Power Company, Ltd. The Durban Town Council has authorised the provision of a supply of electricity to the district of the Kloof, situated on the main railway line 23 miles by rail from Durban and 1800ft. above sea level. The estimated cost of the extension of supply from the terminus of the Northdene scheme, at present in hand, is £7500. The transmission will be at 6600 volts. The Colcolan Town Council is proposing to borrow £5650 to complete the new waterworks, and the Caledon Divisional Council has received estimates for the new bridge to be erected at Elgin, amounting to £9000. Owing to inability to find a solid foundation for the piers the bridge will have to be built on concrete piles driven into the silt. The Indwe Town Council is spending £2500 on extensions to its electrical plant, in the shape of a 50 kW generator, 75 H.P. Belliss and Morcom engine, and B. and W. boiler.

Bricks from Mine Dump Sand.

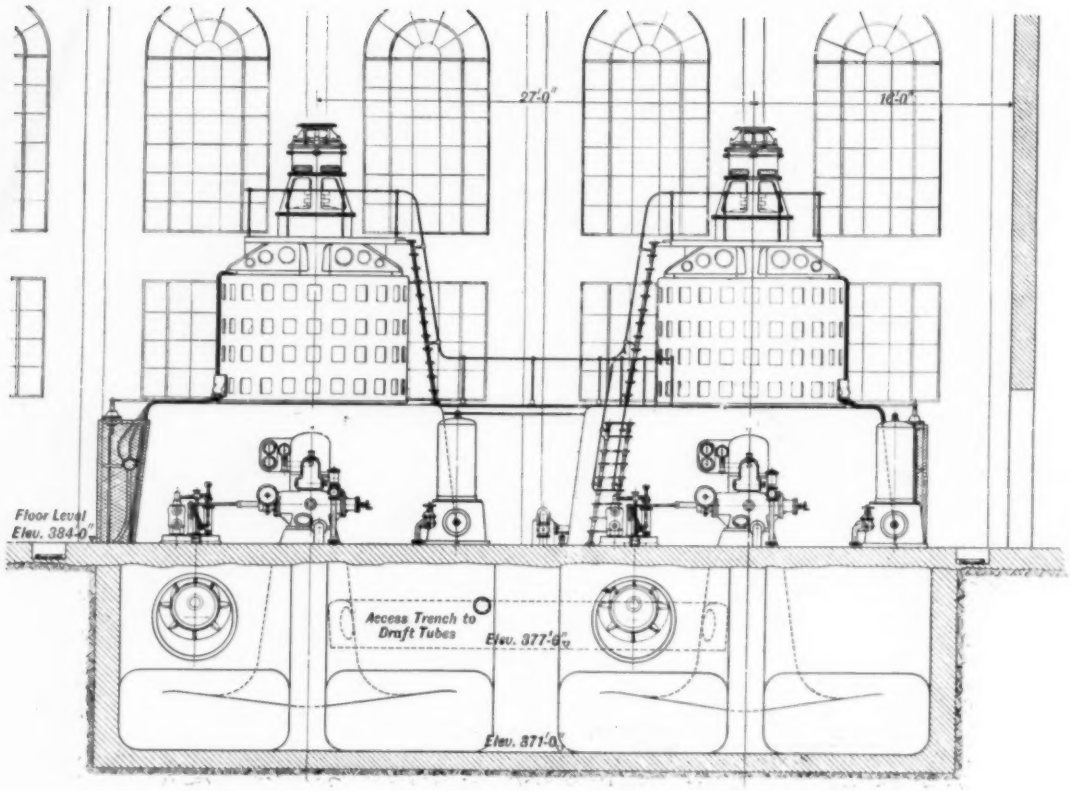
A new industry is being organised to make practical use of the mine dumps which for almost the past forty years have formed the main characteristic of the landscape between Springs and Randfontein. A process has been discovered by which these hills of cyanide sand can be converted to the manufacture of bricks, tiles, pottery and earthenware, and a company known as Synthetic Sandstone, Ltd., is being floated with a capital of £25,000. According to the prospectus, the method of utilising the dumps and slimes deposit has been evolved after exhaustive experiments carried on by the patentee in conjunction with German experts. As an example of the success which has attended the initial experiments, a brick with a pressure resistance of over 2000 lb. to the square inch—which is far in excess of established requirements—was immersed in water for twenty-four hours. It absorbed during this soakage 14 oz. of water, a great deal less than the ordinary brick, which breaks easily thereafter with the stroke of a hammer. The new synthetic brick not only profited by its water absorption, but became hardened to the extent that it withstood blows from a hammer without the slightest damage. Its consistency and resiliency proved to be nearly as great as concrete. As a further test, ten bricks, picked by an inspector, were soaked in water to the fullest extent, and when absolutely saturated they were submitted to a frost exposure of 15 deg. They were next thawed in warm water, and these operations were continued through twenty-five freezing and twenty-five thawing processes. At the conclusion of these tests there was no perceptible difference in the bricks. The pressure resistance was more by far than any brick of the usual building type. The brick can be turned out in any colour or fancy shape and plastering is not required. The manufacture is as speedy as it is satisfactory. Bricks can be completed for building purposes in an ordinary day's shift. Bricks actually produced from mine dump sand have been tested by the German State Examination Bureau (Division of Building Material), and the result is stated to confirm all that has been claimed. The certificate has been issued on seven bricks and five examinations. The cost of production, it is stated, based on South African conditions compares favourably with present-day prices of the average marketable brick. The first seat of operations will be Germiston (Transvaal), where the industry is to be situated on a site in the Rose Deep area.

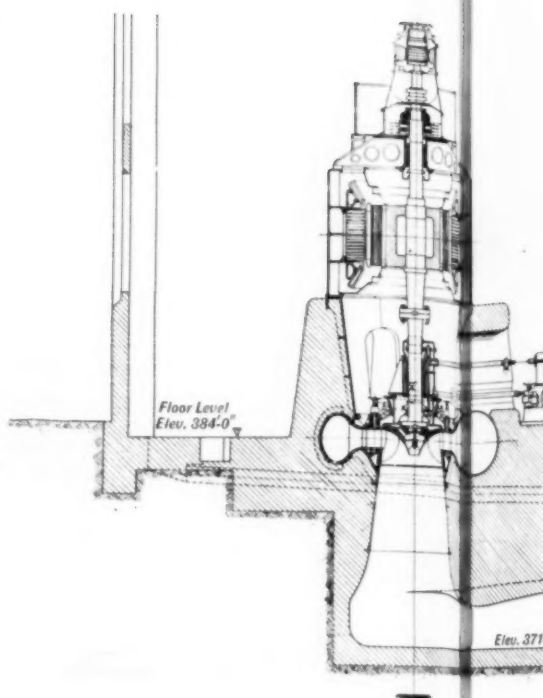
Rand Mine Down 7630ft.

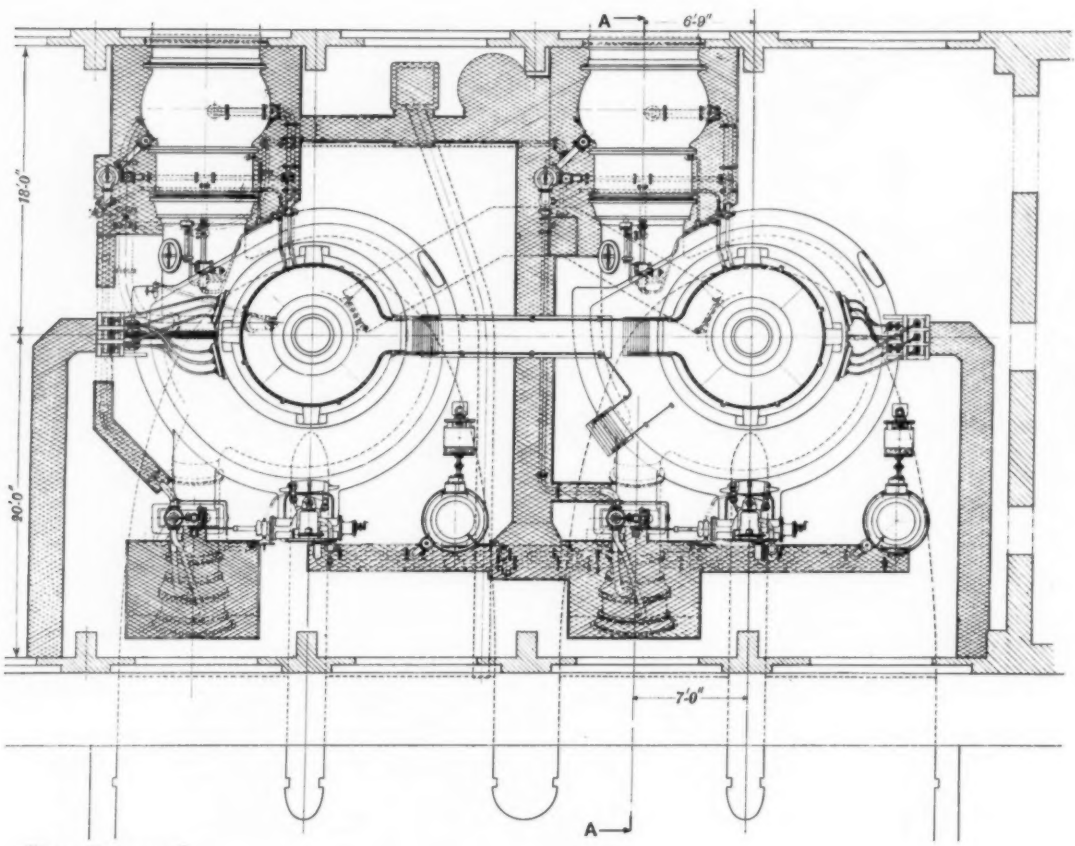
In the Village Deep Mine which lies immediately to the south of the centre of Johannesburg, a vertical depth from surface of not less than 7264ft. has been reached. This is the extreme vertical depth below the collar of the Turf or No. 3 shaft of this property, but inasmuch as the top of this shaft is situated 366ft. below datum, "it may, in point of fact, be said that in the Village Deep a depth of 7630ft. below datum"—that is, the mean level on the Reef—has been attained. As the Village Deep property is constituted to-day, three more levels can be opened out before the extreme southern boundary of the company's property is reached. This would mean the driving of the forty-second level at a vertical depth of about 8000ft. Beyond this is further ground which could no doubt be acquired by the company. The determining factor will, of course, be the economic one, but given reasonably favourable conditions, mining at a vertical depth of 8000ft. in this ultra deep Central Rand proposition during the next year or two is quite within the bounds of probability. Yet the company's sole reef asset is a band of conglomerate, seldom more than 2ft. thick, which is known as the Main Reef Leader and yields 5·6 dwt. per ton of ore, and the profit is so small that the property with its single shaft has to operate like clockwork and on the time-table principle of a railway. Every day 3500 natives and 260 white men have to be lowered and hoisted an average depth of 6300ft. The cost of timbering is naturally a very heavy item and works out at about £10 per foot. Four tons of ice are sent underground every twenty-four hours, namely, 3 tons by day and 1 ton by night. This ice is placed in the main ventilating column and the air from the surface flowing over the ice blocks induces a large reduction of temperature.

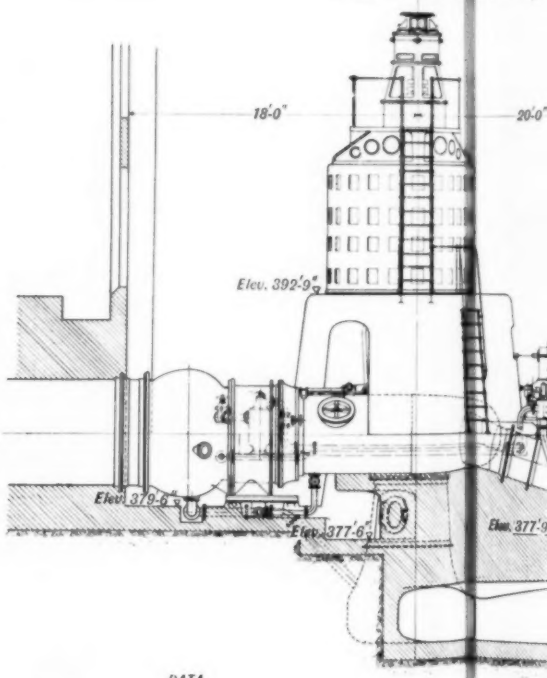
GENERATING SETS FOR THE LANARKSHIRE

THE ENGLISH ELECTRIC COMPANY,









DATA

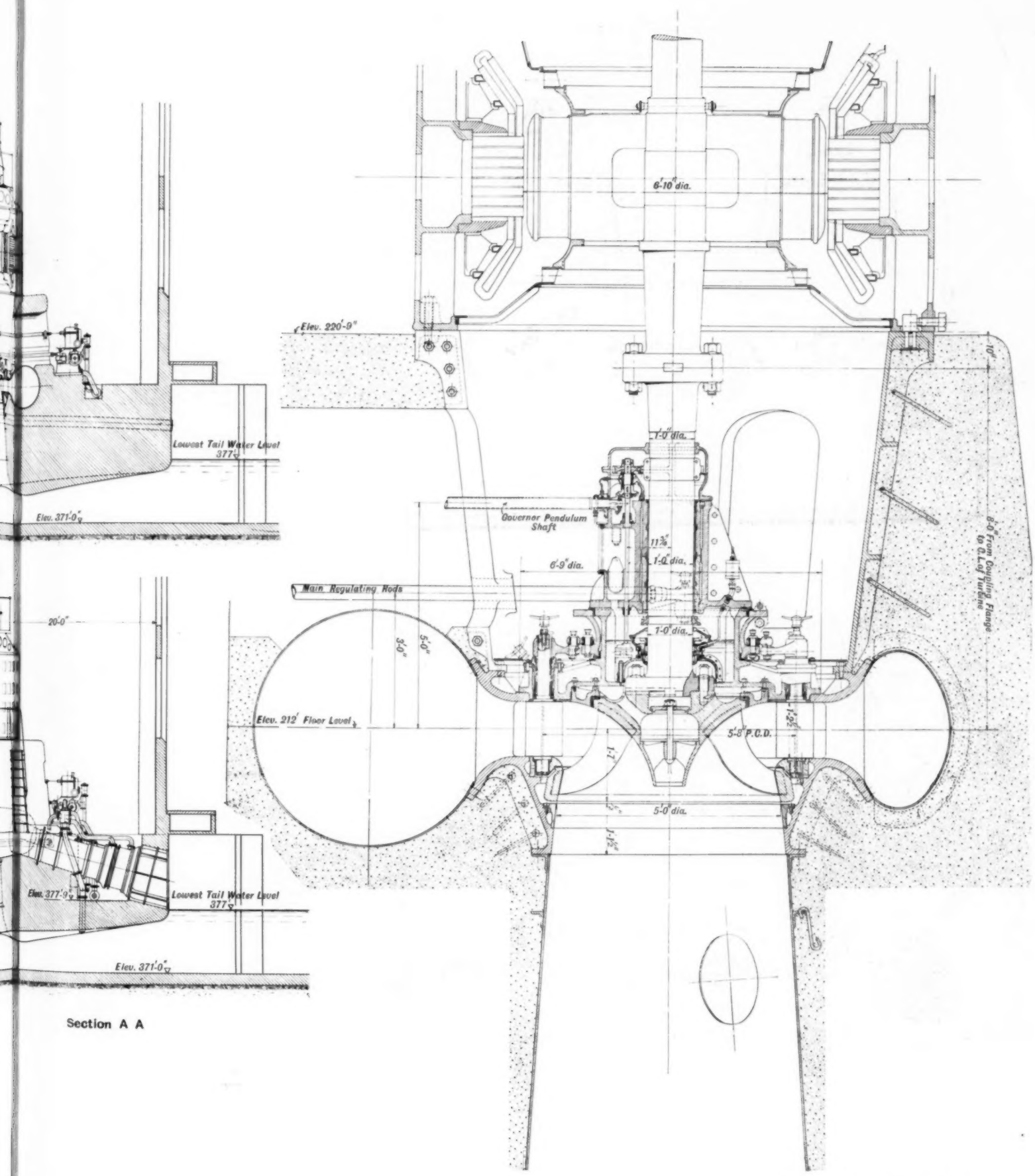
Two Vertical Shaft Reaction Turbines with Sheet Steel Spiral Casings, Cylindrical Balanced Valves, and Relief Valves.
Nett Head: 174 feet = 53 metres
Output: 7000 B.H.P. each
Speed: 375 R.P.M.

"THE ENGINEER"

7000 B.H.P. TURBO-GENERATORS FOR BONNINGTON STATION

KSHIRE HYDRO-ELECTRIC POWER SCHEME

ER COMPANY, LTD., LONDON, ENGINEERS



Section A A

SECTIONAL ELEVATION OF 4000 B.H.P. TURBO-GENERATOR FOR STONEBYRES

Oil-driven Pumping Plant.

WHEN conversion of plant has to be effected engineers often find themselves faced with interesting problems. In the case described in the following article two reciprocating steam pumps, one of which was driven by a beam engine, were in use. The latter, at least, was out of date, and, moreover, they gave some little trouble by occasionally synchronising and putting abnormal stresses upon the rising main. It was therefore decided to replace one of them with a centrifugal pump driven by an oil engine, but it was stipulated that the existing building was to be retained, and was to be altered as little as possible. The centrifugal combines very happily with the reciprocating pump, and the heavy pulsation which occurred from time to time with the old pumps have been entirely obviated.

There has recently been installed in the Walton pumping station of the West Surrey Water Company, a new oil-driven pumping plant, which is noteworthy on several accounts, as it has been put in to supercede an old steam plant without it being necessary to alter the original buildings to any material extent, it has increased the capacity of the station, has already shown an economy in fuel costs, was less costly than a modern steam set of corresponding capacity, and has relieved the rising main of considerable stress. This last merit, it may be pointed out, has been caused by the fact that with the old plant it was occasionally necessary to run two reciprocating steam pumps together, delivering into one main, and although the two sets were arranged to run at different speeds, there naturally arose periods when both pumps were momentarily in synchronism, and then all the water piping system was subject to the stress of both pumps delivering simultaneously. Now, with the new rotary pump working in parallel with the plunger pumps, there is actually a softening out of the impact on the rising main. Incidentally the adoption of the oil engine has provided an alternative system of driving, which, as compared with the coal-fired steam sets, is dependent upon an entirely distinct source of fuel, water and oil, and consequently provides an insurance against the complete shutting down of the water supply.

The new engine and pump, of which we give some photographic illustrations on page 426, while the general arrangement of the plant is shown in the line drawing below, have been supplied by Worthington-Simpson, Ltd., of Queen's House, Kingsway, London, to the instructions of the water company's engineer, Mr. A. T. Hill.

It was decided primarily that the new unit should be installed in the building of an existing set, which comprised a pair of Lancashire boilers and a beam engine, that had not been run for some time; but it was, of course, necessary to alter the foundations somewhat. The walls of the buildings are not strong enough to carry an overhead crane, neither could they be cut away to any great extent, so it became necessary to provide self contained gear for overhauling the new engine set in the old boiler house, while the pump itself had to be driven by an extension of the engine crank shaft reaching through the wall into the old beam engine pumping house. The original feed pump room has provided a convenient alcove—see the plan view—for the accommodation of the outgoing control valves and Venturi recorder.

There is one other feature connected with the utilisation of the old buildings that is worth recording, and it concerns the chimney of the original boilers. This chimney is in good order, but was not worth the labour of pulling down, and would appear, at first sight, to provide an admirable means of getting rid of the exhaust gases of the new oil engine. Mr. Hill, however, decided that it would not be politic to adopt such a scheme, on account of the possibility of the accumulation of unburned gas in the stack and its subsequent explosive ignition. As an alternative he has finished off the exhaust pipe with a big fish tail, with the end of the tail cut off obtusely. The object of this angular end is to prevent the impulse of the individual explosions synchronising as they emerge from the fish-tail. The result certainly is very effective, as, although the pumping station is right alongside the river tow-path, the running of this 300 horse-power engine causes no offence to the pleasure craft on the stream. So much for the general conditions of the plant.

Now, coming to the machinery itself. It comprises a 300 horse-power oil engine driving a two-stage centrifugal pump through speed-increasing gear. The engine is of the Worthington solid-injection two-stroke type, and has four cylinders. It runs as a normal speed of 275 r.p.m., but the speed can be adjusted, while it is running, to 25 per cent. below, or 5 per cent. above the normal. There is a pedestal bearing for the crank shaft outside the fly-wheel, and then a flexible coupling to connect it with the gear-box. The pedestal bearing is arranged, as will be seen from the plan drawing, beyond the partition wall in the pump house.

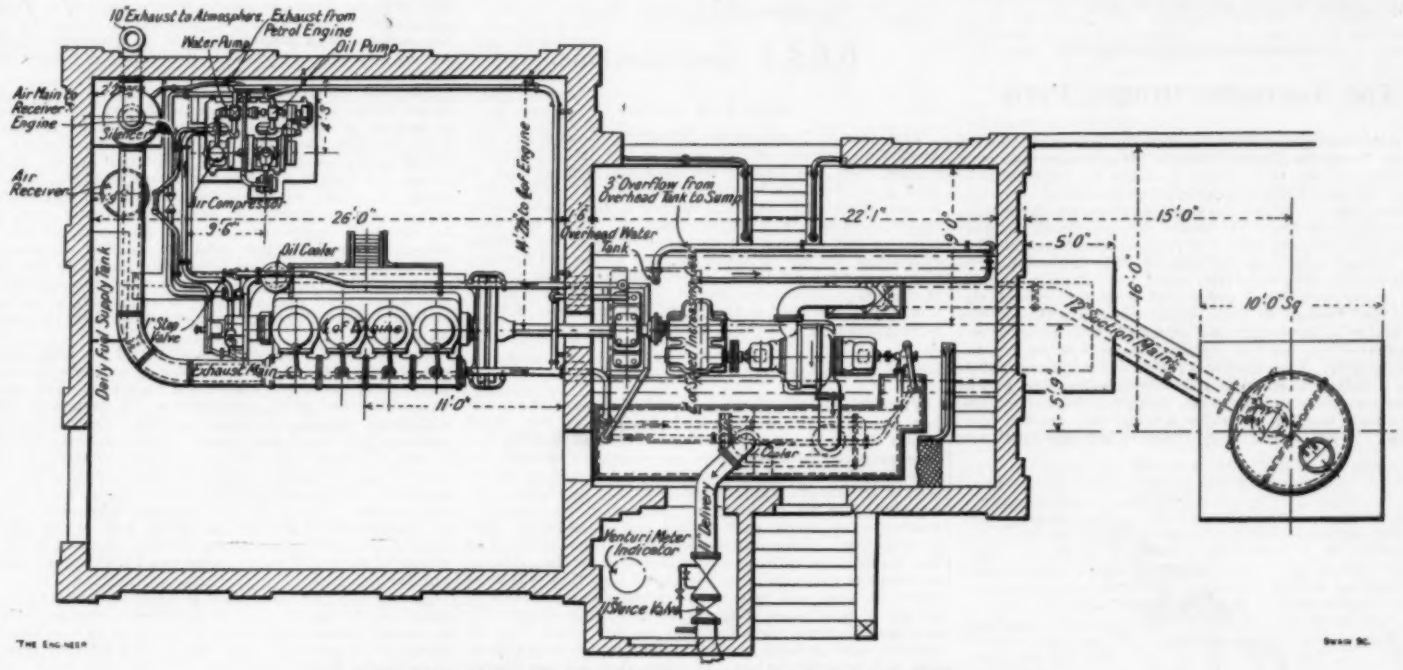
In the engine house there is also an auxiliary set driven by a 4½ brake horse-power petrol-paraffin engine, running at 325 revolutions per minute. Directly coupled with its crank shaft there is a 4½in. by 5in. vertical compressor for supplying compressed air to start the main engine. On the opposite end of the crank shaft there is a pulley for driving two pumps by belt. The belt runs on fast and loose pulleys, and is kept tight by a jockey pulley. One of the pumps is an auxiliary to the pump which is normally used for cooling the main engine pistons by means of the circulation of oil, while the other acts in the place of the jacket-water circulating pump. These arrangements have been adopted so that both at starting and stopping the main engine the circulations of oil and water can be maintained, while the engine itself is standing. There is also a hand pump in the cooling oil circuit for use in case of emergency. When the main engine is running the oil is circulated by a Fuerherd pump, driven off the crank shaft, and is passed through a vertical tubular cooler standing at the end of the engine, through which the jacket-water is first passed, so that the temperature of the oil is kept as low as is possible.

The jacket-water, when the engine is running normally, is provided by a little centrifugal pump on the end of the spindle of the main pump. It is sent up into a tank in the roof of the pump house and gravitates back, through the cylinder jackets and oil cooler to a suction tank. On the way to the overhead tank the water is passed through a tubular cooler through which the whole of the discharge from the main pump passes. This arrangement is preferred to the by-passing of a part of the main pump delivery through the jackets, as any appreciable increase in the temperature of the water sent to the rising main increases its bacteriological content. By separating the two circuits the possibility of contamination is eliminated, and the temperature of the large volume of water delivered by the main pump is not appreciably raised.

The main pump itself does not require much comment, as it is of the maker's standard turbine type with two stages. It has a single axial inlet, and the end thrust is accommodated by a dummy. The capacity is 1900 gallons of water a minute, against a head of 290ft. to 300ft. when running at a speed of 1040 revolutions per minute. When tested at the maker's works the efficiency of this pump was found to be 72 per cent. Both the impellers and guide vanes are of bronze.

The gear, which is used to increase the speed of the engine up to that of the pump, was made by the Power Plant Company, and has a ratio of 275 to 1040. It has double-helical machine cut teeth, and is totally enclosed. A little pump driven off the end of the slow-speed shaft by a chain, the casing of which can be plainly seen in the illustration of the main pump, is used to lubricate the gear wheels independently of the rest of the plant.

On the occasion of our visit of inspection it was noteworthy that the set was running very quietly and smoothly, while it was doing the whole of the morning pumping of the station; but we failed to get from Mr. Hill any comparative figures as to the saving which it is really effecting. He hinted at a saving in fuel alone of about £9 a week, but did not like to give any precise account until the engine had been running for some time. In any case it is obvious that on capital account alone the oil engine set is a profitable investment.



PLAN OF WALTON PUMPING STATION OF THE WEST SURREY WATER COMPANY

The Quarter's Shipbuilding Returns.

LLOYD'S REGISTER shipbuilding returns for the quarter ended September 30th show that the tonnage under construction in Great Britain and Ireland—1,536,416 tons—was 146,028 tons more than at the end of June last, and 761,619 tons more than the tonnage being built twelve months ago. The tonnage on which work was suspended at the end of September, 1927, amounted only to 8488 tons, as compared with 107,498 tons at the end of September, 1926. The present totals, although the highest since September, 1922, are still 354,000 tons below the average tonnage being built during the twelve months immediately preceding the war, *i.e.*, 1,890,000 tons. The tonnage under survey of Lloyd's Register amounts to 1,403,295 tons, which represents 91·33 per cent. of the total tonnage under construction.

A considerable decrease is shown in the tonnage commenced during the quarter, namely, 370,073 tons, as compared with 437,112 tons during the second quarter of 1927. The tonnage launched during the past quarter —355,542 tons—showed the large increase of 86,997 tons, as compared with the figures for the previous three months.

The total merchant tonnage being built in other countries—1,537,641 tons—was about 87,000 tons more than at the end of June, 1927. The tonnage under construction abroad only exceeded by 1200 tons the tonnage being built in Great Britain and Ireland, as compared with over 300,000 tons twelve months ago. The figures for the leading countries abroad are:—Germany, 516,245 tons; Italy, 208,420 tons; Holland, 163,824 tons; and France 130,914 tons. From one of the tables we observe that 399,637 tons were commenced abroad and 179,778 tons were launched, an increase, as compared with the previous quarter, of 63,134 tons in the tonnage commenced, but the large decrease of 129,445 tons in the tonnage launched.

The total world tonnage under construction shown in another of the tables—3,074,057 tons—showed the large increase of about 234,000 tons as compared with the previous quarter, but was still 372,501 tons below the highest pre-war record reached on June 30th, 1913, viz., 3,446,558 tons. There are at the present time under construction in the world thirty-seven vessels of between 10,000 and 20,000 tons each and fifteen of 20,000 tons and upwards. Seventeen out of the thirty-seven and seven of the larger vessels are being built in Great Britain and Ireland. The total figures include one hundred and thirteen steamers and motor ships, each of over 1000 tons, with a total tonnage of 775,632 tons, under construction in the world for the carriage of oil in bulk. Of these tankers, sixty-two of 404,592 tons are under construction in Great Britain and Ireland, and ten of 82,370 tons in France.

The tonnage of vessels now being built in the world which are to be fitted with internal combustion engines amounts to 1,589,510 tons, while the tonnage of steam vessels under construction is 1,468,842 tons. The motor tonnage thus exceeds by 120,668 tons the steam tonnage. In Great Britain and Ireland the motor tonnage under construction amounts to 653,342 tons, equal to 74·1 per cent. of the steam tonnage under construction. In Danzig, Denmark, France, Holland, Italy and Sweden the motor tonnage under construction greatly exceeds the steam tonnage, the combined totals for these countries being 581,544 tons of motor ships and 137,964 tons of steamers. The world figures include eighty-nine motor ships each of between 6000 and 10,000 tons; nineteen of between 10,000 and 15,000 tons; ten of between 15,000 and 20,000 tons; and four of over 20,000 tons.

Another table shows that the total horse-power of the engines being built or being installed on board vessels at the end of September, 1927, amounted to 2,045,049 H.P., of which 944,464 H.P. are being or were built in Great Britain and Ireland. As indicated in the table, the world figures are not complete, since the horse-power of turbines being built in Germany is not available.

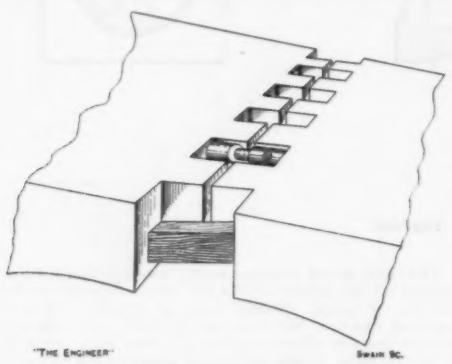
Of the vessels given as being under construction in the

THE NEW TOURNELLE BRIDGE OVER THE SEINE

world—which total excludes vessels the construction of which has not actually been commenced and also all vessels of less than 100 tons—408 of 2,111,856 tons are under the inspection of the Society's surveyors, with a view to classification in Lloyd's Register Book. These figures are the highest recorded since March, 1922.

The Tournelle Bridge, Paris.

An interesting operation has recently been accomplished on the Tournelle Bridge, which is being constructed over the southern arm of the Seine from the Ile Saint-Louis in Paris. It consisted in forcing apart the halves of a concrete span in order to remove the steel gantry on which the ends rested at the centre. This is the first reinforced concrete bridge to be built in Paris. It replaces an old double span iron bridge which caused considerable interference to navigation on account of the central pier. After the Armistice, when there was a great deal of unemployment, the Municipal Council of Paris began the demolition of the old bridge in the belief that, under the then existing circumstances, the work of replacing it could be carried out economically. Then started a period of exceptional industrial activity, when costs rose considerably, and it was found necessary to slow down and even to suspend the operations, leaving in service a temporary wooden footbridge. Work was actively resumed last year, and two



SKETCH SHOWING SERRATIONS IN RIB

of the three parallel single span ribs, which are to support the roadway, are now nearly completed. The total width will be about 80ft. For the construction of the ribs a steel gantry, weighing 210 tons, was built on the old central pier. This gantry was used to support the halves of the span where they met in the centre. The ends, which are separated by steel plates that are removed during the final operation, have a serrated form with four square openings and one at each side—as shown in the accompanying sketch. Into each of the four openings there was placed a hydraulic jack, operated by hand pumps. The total pressure exerted by the jacks in separating the ends was 2400 tons. The halves of the arch were separated 23 mm., which was sufficient to take the load off the gantry, and thereby enable it afterwards to be pushed along the pier in readiness for the construction of the third span. While the jacks were pushing the halves apart, a wooden wedge was hammered in at one side, and at the other side tees were fixed to permit of the amount of separation being accurately measured. When the halves were pushed apart to the required distance the apertures were filled in with concrete. It appears that theoretically the halves could have been safely separated to the extent of 40 mm. A great deal of care had necessarily to be taken to ensure that the concrete was properly set, and before the operation samples were taken from different parts of the bridge for laboratory tests.

The bridge is to be faced with stone from Souppes-sur-Loing, which has been employed for many of the architectural constructions in Paris, including Notre Dame, the Arc de Triomphe, Sacré Cœur, and the Alexander, Mirabeau and Sully Bridges. At the end of the Tournelle Bridge is a huge pedestal, on which will be placed a statue of Sainte-Geneviève. There is still much to be done, not the least difficult work being the removal of the old pier, but it is expected that the new bridge will be opened to traffic in April of next year.

B.E.S.A. Specifications.

RAILWAY RAILS.

The British Engineering Standards Association has decided to remove all reference to the basic Bessemer process from the British standard specification No. 9, 1922, Bull Head Railway Rails, and No. 11, 1926, Flat-bottom Railway Rails, since the use of this process is no longer in accord with British practice. Effect has been given to this decision by the Association in the current editions of the specifications of slips giving the detailed alterations required to the clauses affected. For a copy of these slips application should be made to the publication sales department, B.E.S.A., 28, Victoria-street, S.W. 1, accompanied by a stamped addressed envelope.

WIRE ROPES FOR CRANES.

The British Engineering Standards Association has just issued a British standard specification for round strand steel wire ropes for cranes. This specification has been prepared by committees representative of both the buying and manufacturing interest, and it will, as in the case of all British standard specifications, be reviewed as experience of its working or progress in the industry renders it necessary and revised issues published from time to time. Recommendations have been included in the specification in the form of a foreword for the guidance of designers and users, and it is hoped that they will be of value to users and will ensure reasonable endurance in service of wire ropes of the types and kinds covered by the specification. Specifications for lift ropes and for colliery winding ropes are also in hand by the committees, and will be published as and when they are completed. Copies of the crane rope specification—No. 302—can be obtained from the B.E.S.A. publications department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. post free.

Corrosion by Oil.

A paper of more than usual practical interest was read at a meeting of the Institution of Petroleum Technologists on Tuesday evening last, October 11th, by Mr. Horace J. Young, F.I.C., who described and illustrated a new method he has devised for directly testing the amount of corrosion which may be caused by lubricating oil. The original experiments described by Mr. Young were instituted to ascertain the cause of severe corrosion which had occurred on the pins and journals of the crank shafts of two oil engines installed in a motor vessel, and were carried out at the Neptune Works of Swan, Hunter and Wigham Richardson, Ltd., at Newcastle-on-Tyne. The method, which the author has named the "Direct Oil Corrosion," or D.O.C. test, has since been further developed and applied by the author and his chief assistant, Mr. H. C. Jay, and we learn that Brady and Martin, Ltd., the instrument makers of Northumberland-road, Newcastle, now manufacture testing apparatus of the multiple type used by Mr. Young, which can be conveniently arranged for laboratory and testing shop use. The D.O.C. test consists in allowing warm oil to run continuously over the warmed surface of the steel, white metal, brass, copper or other material it is desired to test. In the original apparatus a 250–1000 c.c. aspirator bottle was mounted above a metal tank filled with water or other liquid heated by a bunsen burner. The oil flowed from the bottle through a U tube immersed in the liquid in the tank, and out at a glass jet over the specimen and into a beaker. The rate of flow was controlled by means of a simple screw clip. The 2in. by 2in. by ⅛in. specimens to be tested were mounted on studs on a triangular bar secured to the front of the tank, which kept them in position and maintained them at approximately the same temperature as the liquid in the tank. The temperature employed by Mr. Young was 10 deg. Cent. below the boiling-point of water, although any desired temperature can be employed to suit given testing conditions. It was found by experiment that the specimens to be tested should be polished to that degree of finish which is produced by No. 0 emery, and that although visual inspection showed the safe or dangerous properties of a given oil, microscopic examination of the surfaces at a magnification of 50 diameters enabled a more accurate and scientific comparison of results to be made.

The oils which caused violent corrosion on the two crank shafts already referred to showed no deleterious properties as judged by the usual chemical laboratory tests, but with the D.O.C. test they were discovered to be highly corrosive, both to steel and white metal. In the course of his paper, Mr. Young refers to tests which he has made on several oils taken from the sumps and lubrication systems of marine oil engines and motor cars, and to standard comparison with a non-corrosive oil—as shown by the D.O.C. test—and five acidified oils made by adding definite quantities of sulphuric acid to the non-corrosive oil. The effects of alkalies and the addition of sea water were also studied. The general advantages claimed for the D.O.C. test are summarised by the author as follows :—

By the D.O.C. test as little as 0·002 per cent. H_2SO_4 can be detected, and the test is equally sensitive to minute amounts of sea water, alkalis and sulphates. The alkalis so readily affect white metal that an oil cleaned by alkali will attack white metal, even when that oil has been washed three or four times with water. The test thus affords a means of testing the efficiency of any cleaning process. In this connection, it has led to the perfecting of a simple appliance which, inserted into an oil system, will keep the oil "sweet." The study of compound lubricants as used on compressors is greatly facilitated, and, at the time of writing, valuable information is being obtained as to the effects of high acid value—oleic—and high saponification number.

In practice, the D.O.C. test is being used as a means of watching the oils on internal combustion engines for land or marine work, and within a few hours of receiving the sample it is possible to tell the owners whether their oil is becoming dangerous to use. In transport work—automobiles, lorries, motor omnibuses—great interest has been shown in this matter, many oils being found to be corrosive. In another direction the opinion has been expressed that the test may throw light upon the pitting of the teeth of turbine gearing, which sometimes takes place in a manner never satisfactorily explained. Corrosion in pipe lines is not unknown, and the work of discovering its progress, cure or prevention may be facilitated by this test.

Electrical Drives in the Paper-making Industry.—The May issue of the *Siemens-Zeitschrift*, the house journal of both the Siemens-Halske and Siemens-Schuckert undertakings, was set apart for a special series of articles on the uses of electricity in the paper-making and allied industries. After an introductory article dealing with the inter-relation of electro-technics and the industries under review, the general development in application of electrical drives is described, and some of the economies which may be gained by utilising electric transmission in the paper-making industry are referred to and made clear by the use of curves and diagrams. There is an interesting chapter on the more recent development of the pass-out type of turbine, and in it are illustrations of several of the more recent turbine installations in German paper mills. The adaptation of the Ruth's type of steam accumulators to requirements of the paper-making industry is also discussed. A short chapter deals with the modern lay-out of power stations in paper mills, while various instruments for the control of heat distribution by electrical means are illustrated and described. Another chapter deals with various types of drive for beaters, paper-making machines and wood-pulping installations. The Siemens-Harland multiple motor driving system is illustrated, and examples are given of the application of the variable speed three-phase commutator motor to rolling-up machines and calenders. Some of the final chapters are devoted to mill and office lighting, electric lifting and transporting appliances, automatic electric wagons, as well as telephone and distant signal communication stations. There are short chapters on the electrolytic process for the production of bleaching liquid and the use of electric precipitation apparatus for dealing with smoke and dust, and electrically-driven machine tools and appliances in paper mill repair shops. The volume, which concludes with a short bibliography of articles dealing with electricity and its application in the paper-making industry, which have been published by the Siemens companies, is well printed and illustrated, and should be of interest to engineers who are engaged in the industries for which it has been specially prepared.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

The large attendance on 'Change in Birmingham to-day—Thursday—for the October quarterly meeting of the Midland iron trade demonstrated the eagerness of producers and consumers of iron and steel to probe the possibilities of business during the next three months. Representatives from all parts of the country ventured their opinion and expressed hopes of better times. The past quarter has been a very disappointing one, and the new quarter can hardly be worse. Optimism was the prevailing note to-day, though there was little tangible evidence of an autumn revival. It must be confessed that though many industrialists anticipate an increase in demand for raw materials, the actual orders placed to-day were not anything like as numerous or bulky as was expected. The meeting did not reveal the development of any strong consumptive demand, but inasmuch as raw material has been bought on very cautious lines for some time past, there are possibilities in the new quarter. The riddle of the future remains unsolved, and representatives left the Exchange almost, if not quite, as perplexed as they entered it. One thing is certain, the blast-furnaces and steelworks are in a greater state of efficiency to-day and capable of turning out larger quantities than they have ever been, so that, immediately any trade revival sets in, they will be in a position to cope with it. It is hoped such a state of affairs will soon develop for industry is badly in need of the benefits to be derived from the reduced costs which increased production should bring about.

Steel.

At to-day's quarterly meeting in Birmingham steelmasters expressed themselves as fairly satisfied with the manner in which their rebate scheme has been taken up, and ventured the opinion that it would be more generally accepted as time goes on. Steel is selling only very slowly, however, and steelworks need more orders. Every contract given out is the subject of keen competition, though price concessions are not involved. Steel mills are issuing very comprehensive rolling lists covering almost every description of building steel, constructional engineers declaring that they have known nothing like it in the history of the trade. This state of affairs is bad for the mills, as it involves frequent roll changing and a consequent reduction of output, with a serious addition of costs. It enables the purchaser, however, to obtain his steel at a day's notice. Values remain substantially unchanged. There has been no marked reduction or increase in steel prices during the quarter, except so far as the rebate, which applies to consumers of British steel only, is concerned. Angles and joists are officially named £7 12s. 6d.; tees, £8 12s. 6d. Ship, bridge and tank plates sell at £8 7s.6d.; boilerplates, £11 to £11 10s. Small bars stand at £7 15s.; mild steel billets £6 10s. upwards. Staffordshire hoops are £10 10s. at works. Foreign steel is competing severely. Birmingham and other merchants carry large stocks of foreign joists, &c., which can be supplied on demand. For current jobs no steel would be ordered from the Continent for from two to three months is required for delivery. It is believed that foreigners are making efforts to speed up delivery, however. Continental prices are low, billets being offered here at £4 3s. f.o.b. Antwerp, and for one and three-quarter inch, £4 8s. 6d. Joists are obtainable at £4 16s. f.o.b. Antwerp. Wire rods, £5 9s. 6d.; plates three-sixteenth of an inch thick, £6 8s. 6d.; and steel bars, £4 17s. 6d. Business in foreign semis has dwindled. Industrial concerns which find themselves overbought are stated to be reselling billets at £5 2s. 6d. and even less. Steelmasters report that inquiries for building steel has improved and cover heavier tonnages. They contemplate a greater output during the next three months than was the case last quarter.

Pig Iron.

Consumers of pig iron displayed rather more interest in the market than they have done of late. With many of them stocks are very low, and they intimated that if furnacemen would meet them in the matter of price they would do business. Ironmasters blankly refused, and threatened to curtail still further the output rather than submit to prices which would aggravate the loss they are already sustaining. As a matter of fact, present prices and conditions are considered so unsatisfactory from the furnaceman's point of view that there was a marked movement towards higher values. Many Derbyshire houses raised their quotation for foundry iron 1s. per ton, and it was claimed that business was negotiated at this figure—£3 6s. f.o.t. What sales there were, however, were too inconsiderable to be interpreted as a real market movement, but they were regarded as an encouraging portent. There were other Derbyshire houses which would have been glad to do business at £3 5s. Northamptonshire makers quoted last week's figure of £3 0s. 6d., and North Staffordshire smelters asked £3 5s. for their output. A little buying into the new year was reported, but it was only in exceptional instances, consumers contracting forward very cautiously. A few users, of opinion that prices are more likely to go up than down, considered it wise to arrange for future supplies at current rates. There were but few transactions in forge material, and it would be difficult to state the market level of prices. Nothing was heard on 'Change of foreign pig. Continental prices appear to be no longer attractive to Midland consumers. Smelters in this area are trusting business will improve during the next three months. They have had a fairly bad time of late, and they would like to be in a position to recommission some of their idle furnaces.

Iron Trades Future.

That the future of the Staffordshire wrought iron trade would depend to a great extent upon the maintenance of the special high class quality material for which Staffordshire's reputation was worldwide, is the view of Mr. F. S. Wilkinson, the new President of the Staffordshire Iron and Steel Institute. He advocated in his presidential address that in future operations small plants not favourably situated for raw materials and with which heavy transport charges obtained, should maintain products of a thoroughly reliable standard, which would command a higher price than those of their competitors, and that better equipped and situated plants should run to full capacity, thereby reducing production costs. He deplored the present state of the industry, but thought there was no need for despair. The future of the industry in this district he considered could continue only with the maintenance of the special high-quality material for which its reputation was worldwide; whenever high-quality material was required for purposes where quality and reliability counted before price, the plants still operating in this area should still find a market for their products. The production of cold-blast pig iron, high-grade wrought iron, chains, anchors and chilled rolls, essentially belonged to Staffordshire, and they ought to see to it that Staffordshire still retained a large share of the trade for these materials. Other industries were coming into the district, which fact should encourage them, for some of these would require goods produced in the iron and steel works, and so help to maintain and possibly improve the present position. Another encouraging feature was that gas engineers and others were now specifying that only British wrought iron should be used in the manufacture of tubes and other articles. One hoped that such a move had not come too late to do something for a revival of the wrought iron industry in Staffordshire. In any case it seemed certain that engineers were still alive to the advantages to be got from genuine wrought iron made by the puddling process as carried out in that district. No fair comparisons could be made between it and the so-called continental wrought iron, which, in many cases, was unsatisfactory in use.

Staffordshire Iron.

Some interesting facts regarding the Staffordshire iron industries, past and present, were also given by Mr. Wilkinson at the same meeting. From statistics published, he found that in January, 1862, in the Dudley and Wolverhampton districts there were 55 firms owning 190 blast-furnaces, of which 110 were in blast at the time, and in the South Staffordshire and Worcestershire area there were in operation 1798 puddling furnaces, belonging to 80 different firms, and 101 distinct works. Very few of the firms now survived. There were about six furnaces in blast in the district to-day, and he supposed that the number of puddling-furnaces was less than 20. The cause of this decline in the industry was circumstances over which they had little or no control. The mineral wealth of the district had, to a large extent, become exhausted. Changes in the industry had brought about new processes. Steel was being used in greater quantities than wrought iron, and raw materials had had to come from a distance, making it impracticable, from an economic point of view, for the old plants to carry on. It did not appear to be a very encouraging outlook for South Staffordshire, but it was a position which had been brought about by changing circumstances, and was not in any way to the discredit of the district as a centre of production of high-class material.

Bar Iron Prices.

The Staffordshire iron mills are very short of work, and scarcely any of them are producing at more than half capacity. The trade position is much as it was three months ago, price depreciation having failed to stimulate demand. The recent reduction of 10s. per ton in the marked bar standard brings the basis to £13. This is the lowest price to which marked bars have fallen since the war. Consumers seem no more disposed to buy at this figure than they did at the higher one, and ironmasters are greatly perturbed as to the future. They would like to affect the optimism of the President of the Staffordshire Iron and Steel Institute, but find it difficult indeed, though they agree there are signs of a return to the use of high grade bars for special engineering purposes. The orders forthcoming up to the present, however, have been very meagre when compared with the productive capacity of the mills, and at to-day's quarterly meeting the inquiries circulating did not raise any great hope for the new quarter. It is often possible at such gatherings to get a rough idea of possible requirements of consumers, but if they knew they kept the knowledge to themselves, all the efforts of ironmasters on 'Change to-day failing to elicit the desired information. The position in the Crown bar department is even less satisfactory. Staffordshire makers have to contend with severe competition. They state that Crown bars cannot be sold on an economic basis at less than £10 10s. or £10 15s. Lancashire competitors are quoting £10 5s. in this district, and would take less if a good specification came their way. Lancashire prices, moreover, do not touch the lowest point of the market, supplies being obtainable at as low as £9 12s. 6d. Such business as is passing is of small scale. Nut and bolt iron is almost unsaleable. Though many local makers would gladly accept £9—or 20s. per ton less than at the last quarterly meeting—for their products they cannot get orders. The Darlaston nut and bolt works and the South Staffordshire hurdle makers are but moderately employed, and are buying their raw material from Belgium at prices with which Staffordshire makers cannot even hope to compete. There is a strong demand for gas tube strip for the manufacture of wrought iron tubes. This material made £11 12s. 6d. without difficulty at to-day's meeting. Tube-makers are anticipating good orders for wrought iron tubes in the near future, stocks in engineers' hands being known to be low.

Galvanised Sheets.

There is no improvement in the demand for galvanised sheets, and some of the larger firms have found it necessary to curtail output. Offers of supplies at below the ruling rates failed to-day to attract buyers. The export markets, on which the sheet mills to a large extent rely, appear to have satisfied their requirements for the time being. Home consumption has been small during the whole of the past quarter. Galvanised corrugated sheets of 24-gauge, which at the last quarterly meeting were making £14 2s. 6d. to £14 5s. were to-day offered at £13 15s. and £13 17s. 6d., though a few mills admittedly adhered to the £14 basis.

Birmingham's Exports to U.S.A.

Exports from the Birmingham consular district to the United States during the third quarter of the year showed an improvement on the aggregate as compared with the corresponding quarter last year. Taking into account, however, the difficulty under which British trade laboured in 1926, the expansion—about 250,000 dollars—is not so large as might reasonably have been expected. Some recovery was shown in the exports of brass manufactures, which have been fluctuating erratically. The value was 72,636 dollars, against 59,816 dollars a year ago, and 35,592 dollars three months ago. Steel sashes made a better showing with a total of 95,521 dollars. There was no improvement in the pen trade, the total falling to 67,926 dollars. Machinery and vehicles totalling 63,424 dollars were not quite so disappointing as in the preceding quarter. Miscellaneous metal manufactures were exported to the value of 140,661, a reduction on the corresponding quarter last year, but an improvement on the second quarter of this year. The value of the needles shipped from Redditch shrank to 97,861 dollars, little more than half the turnover a year before, and nearly 55,000 dollars less than in the April–June quarter.

Mining Electrical Engineers.

The new President of the Warwickshire and South Staffordshire branch of the Association of Mining Electrical Engineers, Mr. W. H. Fellows, formerly of Dudley, and now of Stourton, near Stourbridge, was installed at a meeting of members at Lichfield, on Saturday. Mr. Fellows, who is the youngest President the branch has had, is at present the electrical engineer to the South Staffordshire Waterworks Company. The members were entertained to lunch by Mr. Fred. J. Dixon, M. Inst. C.E., the engineer-in-chief to the South Staffordshire Waterworks Company, who also conducted the party over the Sandfields pumping station, Lichfield. Mr. Fellows, in his presidential address, said that his association with the branch began in 1913, when he joined as a student, and ever since he had been interested in its activities, because it was an association of qualified engineers, and one of the few which actually dealt with practical engineering problems.

Warwickshire Colliery to Close Down.

I learn this week that the Craven Colliery of the Warwickshire Coal Company, Ltd., one of the oldest in the Warwickshire coalfield, is to close down shortly. The colliery, I am given to understand, is practically worked out, and now that the upper coal measures have been reached, inrushes of water have occurred from time to time. "We deem it advisable for safety's sake to close down," said an official on Saturday. About 450 men are now employed at the colliery, and they are under notice to terminate their present contracts. It is hoped that most of the labour may be absorbed by local collieries. The Craven Colliery was at one time the nearest pit to the Metropolitan Market.

Unemployment.

There has been a slight check in the downward course of unemployment in the Midlands area, the latest returns showing an advance of 614 in the number of totally unemployed persons. The previous week, however, there was a decrease of over 7000, so that the position has not been materially worsened. Moreover, it is anticipated that this small addition to the list of workless will be wiped out next week. Even this week the position has improved at Birmingham, Bilston, Coventry, Northampton, Nottingham, Stoke-on-Trent, Walsall, Wednesbury and Wolverhampton. The total of unemployed persons now stands at 129,576.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

A "Tube" for Manchester?

Some weeks ago in this column I gave the outline of a suggested scheme for the construction of an underground railway to link up the centre of Manchester with the outlying areas. For about three and a-half years the matter has been under consideration by the Underground Railway Committee, appointed by the Corporation in March, 1924. The labours of that body were only completed at the beginning of this week. The signed report has been presented to the city's Finance Committee, and, it is expected, will be submitted to the Council at its November meeting. The scheme, it may be recalled, comprises an inner ring and six lines running in various directions to the suburbs. The capital expenditure on the total of 35 miles which the scheme embraces is based on an estimated cost of £250,000 a mile, and altogether is expected to amount to something like £20,000,000. This sum would include the cost of the necessary rolling stock and of the provision of stations. Naturally, in view of the formidable figure, public opinion is divided as to the urgency of the scheme, and in some quarters, with an eye on the municipal elections next month, a certain amount of political capital is being made out of it. However, Alderman Bowie, who is the chairman of the Underground Railway Committee, has expressed the view that if the scheme went to a public vote there would be a majority of two to one in its favour.

Developing Fleetwood.

Important developments pending at Lancashire's great fishing port, Fleetwood, which now occupies the third position in England and Wales, were discussed by Sir Josiah Stamp, the president of the London, Midland and Scottish Railway, when speaking at a function in the

town in connection with the Wyre Dock jubilee celebrations. The railway company is considering a scheme for widening the fish landing stage throughout the whole of its length from the water edge and extending the upper storeys with relative further sidings accommodation. By this means it is anticipated that an additional 50 per cent. of berthage accommodation will be provided, besides extending the area for use for other purposes in connection with the fishing industry. The plans have been completed, but no public statement of the cost, beyond that of Sir Josiah Stamp's that the expenditure would probably run into "six figures," has yet been made. The fact that the company intends shortly to transfer its Belfast steamer service to Heysham has created some uneasiness in Fleetwood, but against this must be set the expressed intention of the company to encourage the development of a general cargo trade in suitable vessels, which, in Sir Josiah's opinion, will ultimately be of considerably greater benefit to the town than any business at present arising from the Belfast–Fleetwood services.

Local Contracts.

A substantial addition to the order books of the locomotive building industry of Lancashire will be provided by the order for twelve locomotives for the Ceylon Government Railways, which has recently been placed with Beyer, Peacock and Co., Ltd., of Gorton, Manchester, by the Crown Agents for the Colonies. Another important contract for Lancashire is that placed by Hull Corporation with the Widnes Foundry Company (1925), Ltd., of Widnes, for the construction of a bascule bridge across the river Hull, at a cost of £86,100, to replace the existing North Bridge. The bridge contract forms part of a bigger scheme, which altogether is expected to cost about £300,000.

Non-ferrous Metals.

With ample supplies of metal in sight, the tin section of the non-ferrous metals market during the past week has had to submit to a further depressing of prices, and on balance cash metal is about £7 cheaper than it was a week ago, the fall in forward positions being fractionally less than this amount. Current values are therefore substantially below what they were a fortnight ago, after the heavy decline then recorded. Much of the moderate buying that has been going on has been on speculative account, the demand from industrial consumers still being on cautious lines. What the immediate outlook for the metal is, is problematical, but the "bullish" element is looking for an improvement in the statistical position to have a firming influence on the market within the next week or two. Copper has shown rather more steadiness during the past week, although this has been due rather to the fact that domestic stocks have shown a fairly substantial decline than to any real expansion of trade buying, which has been confined within relatively narrow limits. This also accounts for a slight recovery in spelter. The weakness in lead, however, has not yet run its course, for there has been a fresh decline in this section of the market, the demand being amply covered by the available supplies.

Iron.

There has been no additional firmness in pig iron on this market since last report, although there has been a perceptible tendency for most of the Derbyshire and Staffordshire concerns offering here to bring their quotations gradually nearer the figure established a week ago by one of the leading Derbyshire makers. The fact that those producers who are selling at somewhat below the maximum are gradually reducing their accumulated stocks and thereby strengthening their position, brings nearer the date when a general advance in prices is expected to be made. During the past week fairly substantial sales of Midland foundry irons have been made, and there is still plenty of inquiry in circulation, for, apart from the anxiety of users to cover themselves forward at the present low prices there is a keenness to replenish stocks which, during the past few months, whilst prices were steadily declining, were permitted in many cases to get very low. Middlesbrough and Scottish makers have not found so good a market in this area because of the difference in prices compared with the Derbyshire and Staffordshire brands, but a slightly better demand for hematite has been reported. Current quotations are about 74s. per ton for Derbyshire No. 3, 73s. 9d. for Staffordshire, 80s. 8d. for Middlesbrough, 89s. 6d. for Scottish, and 86s. 6d. for West Coast hematite. Lancashire Crown bars remain at £10 per ton and seconds at £9 10s., but the demand is still very slow.

Steel.

The steel market here has not reflected the improvement that has lately been experienced in the case of pig iron. There has been a moderate call for joists and sections and tank plates, but principally against the balance of existing contracts or against new orders for early deliveries of small parcels. The fact is that users have little faith in the ultimate stability of present steel prices and the general tendency of consumers is to buy sufficient and no more to cover work already in hand. Joists are quoted at £7 12s. 6d. and ship and tank plates at £8 7s. 6d., less allowances under the rebate scheme. There has been little business passing this week, either in boiler plates or steel bars, quotations for which are at £10 15s. to £11 and £7 15s. to £8 10s. per ton. The demand for imported varieties of steel continues slow, and there has been some easing off in finished products. Semi-finished materials keep fairly steady at the moment at about £5 2s. per ton for sheet bars and £4 18s. 6d. for billets, but joists and sections are easier at £5 13s., wire rods at £6 7s. 6d., and Siemens plates at £7 10s., with Thomas plates unchanged at £7 2s. 6d., and steel bars at £5 13s. per ton for delivery to Lancashire works, for cash against documents.

Scrap.

The demand for non-ferrous metal scrap has been a little brisker during the last week or two. Mixed copper is quoted at £54, good gun-metal at £52, scrap zinc at £20 to £21, scrap lead at £20, and heavy yellow brass at £43 to £44 per ton, for sorted and graded qualities delivered to buyers' works.

BARROW-IN-FURNESS.

Hematite.

There is a slightly better tone in the hematite pig iron market in this district. Buyers are showing a tendency to place orders for slightly bigger tonnage, and there is just a possibility that America in the early future may develop into a fair customer. In the Cumberland district stocks have been accumulating in some of the works which have not steel departments and at which a week or so ago there was a suggestion of a reduction in output. It is possible that with the improvement in trade which is expected by many the present number of furnaces will be kept at work. It is, perhaps, too early to be quite sure as regards the trend of business, but there are signs undoubtedly of better trade. This, of course, applies to the better qualities of non-phosphorus iron, as well as the ordinary mixed Bessemer numbers. In the steel trade there is a slightly better feeling and orders for railway material at any rate, as far as Barrow is concerned, assure a constant run this year. It is hoped in the next few months that further orders may be secured. The market is not very brisk, but there are a few orders about and these are likely to be placed this year. The iron ore trade remains moderate, and there will be no developments for the better until more furnaces are put into blast, which is not likely at present.

Shipbuilding.

The reference made to a new Orient liner at the luncheon which followed the launching of the Orford from Vickers' yard at Barrow the other week is creating a considerable amount of interest locally. Vickers have built and completed two Orient liners, the Orama and the Otranto, and the Orford is now being completed in the Devonshire Dock. The proposed new Orient liner will be slightly bigger than the Orford, and it is generally hoped in Barrow that the order will come to Vickers. This will provide a considerable amount of work locally. How much the Orama, Otranto and Orford have brought to the town of Barrow in the way of employment may be gathered from the statement of Sir Allan G. Anderson, K.B.E., who said that in each of the last four years the Orient Company had spent about £1,000,000 per year on shipbuilding.

SHEFFIELD.

(From our own Correspondent.)

Steel Orders Decline.

In the heavy steel melting departments business continues to taper off in a most disappointing manner. For a considerable time there has been marked evidence of a drop in the demand for basic materials, and twice within the last few months it has been found necessary to reduce the number of furnaces in operation in order to keep the output more in line with the sales. This downward tendency, unfortunately, continues, and it has to be confessed quite frankly that at the moment the prospects are gloomy. Owing to the intermittent character of the employment at some of the large plants, it has been found necessary to rearrange the working hours of the men. In some cases a system of a week on and a week off has been introduced. In spite of this somewhat depressing prospect, business men are still confident that a big steel-buying movement will develop before very much longer. The matter largely turns on the financial stringency which many buying firms are experiencing, and if a freer turnover could be established conditions would rapidly improve. As it is, stocks are practically exhausted, but firms are so hard pressed that they are buying from hand to mouth. As conditions are at present, users profer to continue their waiting policy. Railway companies and private wagon owners are among those who have been buying very lightly, and a good renewals programme in that direction should make considerable difference to Sheffield and district firms. Better conditions prevail in the market for special quality steels. A fair amount of work is coming through, and there are plenty of inquiries about. The ordinary lines of engineering do not present any outstanding features. Most of the work is still for the lighter branches, but it is reported that a good number of firms, which can accept heavy finished business, expect to be much busier towards the end of the year.

Tools, Cutlery and Plate.

On the whole, the tool trades are picking up, but an unsatisfactory item of news is the announcement of the serious effect on many local firms of the poor garden and farm season. Large quantities of tools have been left unsold, and the general purchasing power of the land industries has been reduced. The cutlery and plate trades continue to develop their seasonal activity. Compared with this time last year, prospects are considerably better. At that time, of course, the coal dispute was in operation, and that naturally upset the sale of Christmas goods, shopkeepers having to buy with the greatest caution. A normal demand is being allowed for this year, and orders are being placed with a certain amount of freedom. A good many requests are being received for cheap cased goods, and some very attractive lines have been prepared. Trade, however, is not being confined to this section, for a nice lot of orders are coming through for good-class electroplate and best quality stainless cutlery and other tableware. During the quarter ended September 30th the value of the imports of Sheffield cutlery into the United States increased from 28,818 dollars to 76,494 dollars. Large shipments of material used in the safety razor blade industry accounted for this increase. The exports of complete safety razors and blades amounted in value to 1347 dollars. During this period the value of the steel sent from the city to the States was 270,856 dollars, an increase of 40,000 dollars on the corresponding quarter of last year.

New Power Station.

The directors of the Yorkshire Electric Power Company are arranging for the first section of the Ferrybridge power station, which is now completed, to be on view for inspection, and invitations have been sent to power users, local authorities, Chambers of Commerce and other bodies. The first section of the station includes two 19,000 kW turbo-generators with the necessary boiler plant and auxiliary machinery. The ultimate capacity of the station will be not less than 180,000 kW. The site is an ideal one for supplying the needs of the West Riding, and the station will form an important link in the national electricity scheme. An exhibition of industrial electrical appliances in operation will be an interesting feature, and will enable the visitors to see some of the many uses to which electricity is now put.

Pit Head Baths.

The Maltby Colliery is the latest to have baths installed at the pit head. They have been erected at a cost of £12,225, towards which a sum of £9225 has been provided by the Miners' Welfare Fund. The baths include eighty-nine showers, and special care has been taken with regard to lighting, heating, ventilation and the arrangements for drying the clothing. By 1931 a sum of £198,000 will have been spent on pit head baths in South Yorkshire and £102,000 in West Yorkshire.

Foreign Cable Order.

Chesterfield Electricity Committee has accepted a tender for electric cable from the Northern Cable and Wire Works Company, Ltd., Copenhagen, amounting to £1329. This was the lowest tender submitted. Considerable opposition to the sending of this work abroad was voiced at the Council meeting, but in spite of that it was accepted. In a statement on this matter, the Mayor said that it was common knowledge that, owing to the prevalence of a strong "ring" in cable production, it had been deemed necessary by many authorities in England to go outside the country to purchase cable. The Committee had no desire to place foreign contracts, but it could not lend itself to paying a monopoly price which was artificially created by a "ring" of manufacturers.

Bridge Contract Placed.

Hull Corporation Bridges Committee has accepted the tender of the Widnes Foundry (1925), Ltd., at £86,000, for the construction of a new bascule bridge over the river Hull to replace the existing North Bridge. This is part of a big improvement scheme, which, it is estimated, will cost £300,000. The new bridge will be completed in 2½ years.

NORTH OF ENGLAND.

(From our own Correspondent.)

Shipbuilding Brighter.

The outlook for shipbuilding in the North of England is distinctly better. On the Wear, which has felt the long spell of depression severely, the prospects have lately shown marked improvement. Two yards at least are stated to be full up with orders that will keep them going at full pressure for the next eighteen months. The launches on the river last month exceeded those of any previous month of the present year, the total output up to the end of September being only two fewer than for the whole of last year. The Tees is also participating in the upward movement. This is evident by the fact that during the past few days Smith's Dock Company, Ltd., of South Bank, has booked no fewer than eight orders for ships, in addition to the two 9000-ton steamers for which an order was received from Sir Robert Ropner and Co., Ltd., a little over a fortnight ago. The new orders cover two colliers, each 300ft. in length, and designed to carry about 4600 tons of cargo coal, and six special grain steamers, each 260ft. in length, and designed to carry about 2500 tons deadweight on the light draught demanded of ships for service on the Canadian Lakes. In each instance, the main propelling machinery will be constructed in the builders' own engine works at South Bank. These orders will provide work to keep the shipyard and engine works going at top pressure for a year, and when in full swing will call for the employment of 2000 men. Shipyard workers will not be the sole beneficiaries as the result of the new orders. British material will be used virtually throughout, and in great part the steel plates and sections will be rolled in the Tees-side mills. Orders for more than twenty ships have been placed with Tees-side yards during the past few months. There are welcome, if not pronounced, signs also of improvement on the Tyne.

Cleveland Iron Trade.

The tone of the Cleveland pig iron market is distinctly good. Some rather substantial contracts have been arranged during the past few days, and several producers are stated now to have quite good order books. Considerable continental competition has still to be contended with, but Cleveland iron is once more forcing its way into markets that have been almost entirely monopolised by foreign materials for the past two or three years. Stocks of pig iron are steadily decreasing, and the quantities now lying at makers' yards amount to little. Reductions in furnacemen's wages and the cheapening of coke have eased working expenses, but ironmasters declare that market quotations for pig iron are still unremunerative. For home purposes No. 1 Cleveland foundry iron is 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; and No. 4 forge, 66s.; while for shipment to Scotland and overseas destinations quotations are 2s. 6d. below the foregoing figures.

Hematite Pig Iron.

Prospect of an early increase in the production of East Coast hematite has assisted to weaken values of that commodity. Makers still hold large stocks, which they are

anxious to liquidate, and mixed numbers are freely offered at 72s. 6d., both for home use and export. No. 1 grade is put at 6d. above mixed numbers.

Ironmaking Materials.

The foreign ore trade is lifeless, and resumption of market operations is not looked for until consumers have accepted a considerable proportion of delayed deliveries. Nominally, best Rubio ore keeps at 21s. per ton c.i.f. Tees. The unprofitable prices at which Durham blast-furnace coke is offered fail to tempt users, who persist in seeking lower terms, notwithstanding the makers' threat to put out ovens rather than further to reduce quotations. Good medium qualities are on sale at 18s. per ton delivered at the works.

Manufactured Iron and Steel.

Under the rebate scheme finished iron and steel manufacturers are anticipating some improvement from the shipbuilding side, but it is doubtful if order books are keeping up to the level reached a few months ago. Imports of Belgian and French steel show a decline. The market is firm and prices are unchanged.

The Coal Trade.

There is no sign of any improved demand in the Northern coal trade, and both for early positions and over the next two or three months the outlook is disappointing. There is not a bright spot in any section. Fitters of all descriptions of coal have to rely on merchants taking out contract quantities, which are, of course, mostly at prices much above current values, and thus entail heavy losses on exporters. What little new business is passing is being secured by contractors to clear their commitments. The general demand is very limited, and working at the pits is consequently irregular. Orders for Northumberland steam coals are slow in coming forward, and the price in second hands is weak in tone. Collieries are quoting at about the late range of values, but they are not all situated alike. Some are asking full current figures, while others are not so strong in their attitude, as the difficulty in keeping pits going is recurrent. Prices range from 13s. 6d. to 14s. Steam smalls are steady in value, as they are not being produced much beyond market needs. In some parts of the gas coal districts resort has had to be made to the closing of unprofitable seams, and in other instances men have been given notice owing to lack of agreement for cutting down costs. Pits that have been losing money heavily are now getting to about the end of their tether. In the main, gas fuel is better situated than steam coals, and producers are not moving from current quotations. Coking coals have been selling rather better, but are dull again. The market for gas coke remains very good, and makers are heavily pressed to meet the October demand, 21s. being readily obtainable, and for next month there is a tendency amongst sellers to hold out for 21s. 6d. Patent foundry cokes have a fairly good trade but supplies are plentiful at 17s. 6d. to 18s. 6d. Beehive coke is steady at 25s. to 30s.

Coal Miners Under Notice.

Notices to terminate their employment within fourteen days at Pease and Partners' Eldon Colliery have been served on 700 hewers and datal men, owing to the lack of trade. This number, which represents half the total employed at the colliery, includes workmen engaged in three seams, as well as several surface men and mechanics. Notices have also been served on 512 men and boys employed at Houghton-le-Spring Colliery, owned by the Lambton, Hetton and Joicey Collieries, Ltd. For some time negotiations have been proceeding between the the management and workmen on the subject of the removal of stone from the coal in the Five-Quarter seam. As an agreement has not been reached, the owners have decided to close the major portion of the seam. It is, of course, still possible that an amicable arrangement may be made between the parties before the notices expire.

Ironstone Miners' Wages.

The Cleveland ironstone mineowners and miners' representatives failed this week to arrive at an agreement on the question of wages to be paid during the current quarter. The owners claimed that on the sliding scale they were entitled to reduce wages from 64 per cent. above base rates to 49 per cent. They were, however, willing to compromise upon 9 per cent., but this was not acceptable to the men's representatives. A further conference is to be held after the men's representatives have explained the position to the lodges in the district.

Iron Trade Wages.

The ascertained price of No. 3 Cleveland pig iron for the past quarter has been certified at 67s. 2·43d. per ton, and in accordance with the sliding scale arrangement, blast-furnacemen's wages have been reduced by 7·50 per cent., which brings the wages from 20·50 per cent. above the standard to 13 per cent. above the standard.

Engineering Enterprise.

Dorman, Long and Co., Ltd., Middlesbrough, have decided to establish constructional and bridge-building shops in India, and Sir Arthur Dorman, Bart., chairman of the company, is shortly leaving for that country in connection with the scheme.

SCOTLAND.

(From our own Correspondent.)

New Contracts.

During the past week important shipbuilding contracts have been secured by shipbuilding firms on the Clyde. Furness, Withy and Co. have ordered four motor ships for the Prince Line. Two of these vessels will be built by Lithgows, Ltd., Port Glasgow, and two by Napier and Miller, Old Kilpatrick. The engines will be constructed John G. Kincaid and Co., Greenock. Another contract for a motor ship has been placed with the Fairfield Shipbuilding and Engineering Company, Glasgow, for a motor ship of 9130 tons gross, on behalf of Bibby Brothers and Co., Liverpool. The engines will be Fairfield-Sulzer internal combustion. Glenfield and Kennedy, Kilmarnock, have secured the contract for the supply of the sluice gates for the Panjnad Barrage on the river Sutlej in India. The contract includes thirty-three gates of the free roller type, complete in all details, including mild steel superstructure and balance boxes and special lifting gear. These gates will have a span of 60ft. and a depth of 13ft. 6in.

Steel.

The position of the steel market is not encouraging. Orders for most classes of material continue scarce, and inquiries are not such as to hold out hope of an early improvement in the activity at the works. Buyers are evidently taking no risks, and only immediate requirements are considered. One large manufacturing concern has suspended operations until busier times set in, and others may follow suit. Specifications for plates and sectional materials are especially slow. Prices are unchanged.

Steel Sheets.

The recent demand for light steel sheets has been only moderate, and makers' expectations have not been realised. Heavy steels are quiet.

Tubes.

Butt-welded tubes have met with a brisk demand, and solid-drawn tubes are fairly busy.

Iron.

The bar iron works are poorly engaged in their iron and re-rolled steel departments alike. Despite reductions in prices the flow of orders is intermittent, and the quantities, as a rule, comparatively small. Bar iron for export is quoted £10 5s. per ton, but a lower figure can be secured for a good specification. A similar remark applies to re-rolled steel bars, which are quoted £7 7s. 6d. per ton for export.

Exports and Imports.

Exports and imports have been unusually light during the past week. The quantity of iron ore discharged at Glasgow only amounted to some 4500 tons, while manufactured iron materials were represented by 700 tons from Antwerp. Exports of manufactured iron only reached a total of 1700 tons altogether.

Coal.

The outlook in the coal trade has not improved during the week. The lack of shipping business is still pronounced, and the rate of inquiries is not in any wise reassuring. Some Lanarkshire fuels have found an outlet in the Irish market, and Ayrshire fuels are going to similar destinations, but East of Scotland collieries, especially in Fifeshire, have no steady outlet, consequently considerable quantities of fuel have been thrown on the home market, and this has had a detrimental effect on house coal, which has weakened somewhat from the firm position assumed a week or so ago. Industrial demands continue below normal and gas and electricity concerns are not taking lavish deliveries. Apart from Lanarkshire best coal, Lothians steams and treble nuts, the market is weak. Aggregate shipments amounted to 278,271 tons, against 248,984 tons in the preceding week, and 262,605 tons in the same week in 1925.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

It would be idle to pretend that there has been any improvement in the general state of the steam coal industry since writing a week ago. The conditions have been bad, and it would be difficult to point to any really hopeful indication as regards the future, except that it is hard to think that the conditions can become any worse, and that therefore any change that takes place must be for the better. The fact is that at the end of last week the number of idle loading appliances at the various docks in this district amounted to the high total of forty-seven, and although tonnage arrived fairly freely over the week-end, this week commenced with thirty vacant loading berths, which is not a healthy position for the collieries. Within the past week or so pits which have not had to suspend operations for the same reason since 1921 have had to stop working for the want of empty wagons; while one important undertaking had the almost unique experience of having the whole of its pits idle on one day on account of the slackness of orders. Exports last week came to just over 415,000 tons, which was an improvement of over 13,000 tons upon the previous week's shipments; but it should be pointed out that this higher return was brought about by the increased shipments of anthracite from the Swansea district, and was not brought about by increased activity in steam coals. Unfortunately, the foreign demand for steam coals does not expand, and the continental inquiry is very limited, while in view of the over-production in the continental coalfields and the unemployment problem which has to be grappled with there, it is hard to see how the demand for coals from this country can materially increase for some time. So far as Belgium is concerned, there is no further news to hand regarding contemplated action in the direction of restricting the importation of coals, except that the whole position affecting the coal industry in that country is under consideration by a Government Committee. So far as can be ascertained extremely little business of any importance has been fixed up lately in steam coal, except that the Norte Railways of Spain have bought about 20,000 tons of Admiralty large coals for delivery over the next two months, but the French Marine, which was in the market for 40,000 to 50,000 tons of best large coals, has not come to this district for its requirements, the order having gone for French fuel.

Transport Costs.

In the course of a statement dealing with the incidence on the South Wales coal trade of the increases which have taken place in the cost of transport through the raising of railway rates and dock charges, Mr. Finlay Gibson, the secretary of the South Wales Coalowners' Association, recalls that the audit of the trading results in the coalfield for the three months ended last July showed a loss of over £500,000, and he says that it may come perhaps as a surprise to most people to be told that during the same period the cost to the trade of the higher railway rates and dock charges amounted to approximately £800,000. Based on the shipment of 7,600,000 tons of coal, the increase in the railway rate of 9d. per ton, in tipping and weighing of 5d. per ton, and wharfage of 1½d. per ton, represents £482,916; inland coal, which amounted to 3,250,000 tons, upon which the increased railway rate of 1s. 1d. per ton was charged, means a total amount of £176,000; while 400,000 tons of pitwood, with increased railway rates and dock charges of 2s. 8d. per ton, account for £53,333; thus making an aggregate of £712,249. The balance of £88,000 is represented by the cost of the higher railway rates on stores, material, &c., and of other charges levied by the railway company which were not in force in 1913. It will thus be seen that on the basis of these figures the added burden of the expenditure on the transport and shipment of coal and on the conveyance of pitwood is at the rate of approximately £3,200,000. But that is not the whole of the disability against which the mining industry in South Wales is struggling. At the South Wales ports the costs of trimming, tonnage dues, pilotage fees, &c., have been increased. In the aggregate, these port expenses have meant the addition of approximately 9d. per ton on all coal handled at the docks. On the volume of the coal export trade this is equivalent to a further annual charge of £1,140,000, thus bringing the gross increase over the pre-war cost of carrying and shipping a similar quantity of coal to a total of no less than £4,340,000.

Coal Combines.

The question whether coal combines and amalgamations are beneficial or otherwise is a very open matter, but it is one which has raised a good deal of discussion consequent upon an address which was delivered on Tuesday, by the President of the Cardiff Publicity Club, Mr. J. E. Emlyn-Jones, who is the head of the firm of Messrs. Emlyn-Jones, Griffin and Co., coal exporters, &c., and whose subject was "What is Wrong with Cardiff?" He said that an examination of the financial position of certain colliery undertakings pre-war and to-day would make one realise the serious consequences of the combine system. The dissipation of reserves which it entailed had intensified the parlous condition in which so many of their coal undertakings found themselves. The brutal truth was that many undertakings became the play-things of the astute financiers. Amalgamation of interests he described as an unmitigated evil, harmful to the trade itself and stifling to the spirit of enterprise. A small fraction of the money dissipated in recent years in the coal trade, with no communal advantage, would have kept a whole army of scientists busy for years, with far-reaching results to the trade of the district.

New Tonnage.

Sir William R. Smith and Sons, Ltd., of Cardiff, have just placed a second order for a motor vessel of 8600 tons deadweight. It is to be built by Napier and Miller, Ltd., on the Clyde, and to have engines of the Burmeister and Wain type. Sir William Seager and Sons have also ordered from the Northumberland Shipbuilding Company (1927), Ltd., a steamer of about 9000 tons deadweight, on behalf of the Tempus Shipping Company, Ltd. It will be a coal-burning vessel and the engines are to be supplied by the North-Eastern Marine Engineering Company, Ltd., Wallsend-on-Tyne. Since the coal stoppage, orders have been placed for thirty-seven vessels by Cardiff firms.

Power Company Appointment.

Mr. J. W. Beauchamp has been appointed general manager of the South Wales Electrical Power Distribution Company, Ltd., and the South Wales Power Company, Ltd., in succession to Mr. W. A. Chamen, who retires at the end of this year. Mr. Beauchamp has been associated with electric power supply for many years, mainly in industrial districts.

Current Business.

The demand for all qualities of large coals continues to be on very modest lines, and quite inadequate to keep the majority of undertakings engaged working anything like fully. Colliery stoppages have been numerous, owing to the insufficiency of prompt orders and the excessive quantities of coal standing in wagons. Prices have not, however, given way to any appreciable extent. Smalls remain steady and sized coals, especially dry qualities, are quickly absorbed. The patent fuel and coke inquiry is slow, but pitwood continues to be well maintained in price, owing to the curtailed supplies which are being imported.

New Source of Water Supply for Newport.—It has been brought to our notice that, in the description of the new source of water supply for Newport, which appeared in our issue of October 7th, it was not made sufficiently clear who designed and carried out the Talybont undertaking. To remove any misapprehension on the subject, we may say that from the year 1917, when he made his first report on the matter, Mr. E. P. Hill, M. Inst. C.E., of Messrs. G. H. Hill and Sons, of Westminster, has been solely responsible for the scheme in every stage. He prepared it, took it through Parliament, designed the works, and supervised their construction.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	21/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 16 0	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 14 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 15 0	3 15 0
No. 1	3 15 6	3 15 6
Cleveland—		
No. 1	3 10 0	3 7 6
Silicious Iron	3 10 0	3 7 6
No. 3 G.M.B.	3 7 6	3 5 0
No. 4 Foundry	3 6 6	3 4 6
No. 4 Forge	3 6 0	3 3 6
Mottled	3 5 6	3 3 0
White	3 5 6	3 3 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
„ „ Foundry	3 5 0 to 3 6 0	
(3) Northampton—		
Foundry No. 3	3 1 0	—
Forge	2 15 0	—
(3) Derbyshire—		
No. 3 Foundry	3 5 0 to 3 6 0	
Forge	3 0 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 4 0 to 3 5 0	
No. 4 Forge	3 2 6	—
Basic	3 2 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 7 6 (a) / 4 10 6 (b) / 4 14 0 (c)	— / — / —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 15 0	10 10 0
Best	—	
N.E. Coast—		
Iron Rivets	11 15 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Lancs.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	12 10 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	12 5 0	—
Hoops	12 10 0	—
Midlands—		
Crown Bars	9 12 6 to 10 0 0	
Marked Bars (Staffs.)	13 0 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	
Gas Tube Strip	11 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 2 6	7 12 6
Sections	7 12 6	7 2 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	14 5 0	£14 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 2 6	—
Angles	7 12 6	—
Boiler Plates	12 10 0	—
Joists	7 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	
Billets	7 10 0 to 10 0 0	
Manchester—		
Bars (Round)	8 10 0	—
„ (Small Round)	7 15 0	—
Hoops (Baling)	10 5 0	10 0 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 7 6	—
„ (Lancs. Boiler)	11 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 12 6 to 8 2 6	
Intermediate Basic	7 10 0	—
Soft Basic	7 0 0	—
Hoops	10 0 0 to 10 10 0	
Soft Wire Rods	9 5 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 0 0	
Billets and Sheet Bars	6 10 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	13 17 6 to 14 0 0	
Angles	7 12 6	—
Joists	7 12 6	—
Tees	8 12 6	—
Bridge and Tank Plates	8 7 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin cash)	262 5 0
„ (three months)	260 0 0
Copper (cash)	54 7 6
„ (three months)	54 11 3
Spanish Lead (cash)	20 3 9
„ (three months)	20 17 6
Spelter (cash)	27 1 3
„ (three months)	26 15 0
Manchester—	
Copper, Best Selected Ingots	62 2 6
„ Electrolytic	62 17 6
„ Strong Sheets	86 0 0
„ Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price), lb.	0 0 11½
„ Condenser, lb.	0 1 1½
Lead, English	21 17 6
„ Foreign	21 0 0
Spelter	27 5 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 17 6	7/3
„ „ 8 p.c. to 10 p.c. „	£22 10 0	6/6
„ „ Specially Refined		
„ Max. 2 p.c. carbon	£36 0 0	11/6
„ „ „ 1 p.c. „	£41 10 0	13/-
„ „ „ 0·70 p.c. carbon	£53 0 0	17/6
„ „ „ carbon free	1/4½ per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£12 0 0	for home, £16 for export
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0	scale 5/- per unit
„ „ 75 p.c.	£20 5 0	scale 6/- per unit
„ Vanadium	14/3 per lb.	
„ Molybdenum	5/- per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Ferro-Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/-
„ „ Ell	13/6 to 13/9
„ „ Splint	14/3 to 15/-
„ „ Trebles	14/- to 14/6
„ „ Doubles	13/- to 13/3
„ „ Singles	12/-
Ayrshire—	
(f.o.b. Ports)—Steam	13/6 to 14/-
„ „ Jewel	15/6
„ „ Trebles	14/6 to 15/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	11/6 to 12/6
Screened Navigation	18/-
Trebles	15/- to 16/6
Doubles	13/3
Singles	12/6
Lothians—	
(f.o.b. Leith)—Best Steam	12/6 to 12/9
Secondary Steam	12/-
Trebles	14/6 to 15/6
Doubles	13/6 to 13/9
Singles	12/3

ENGLAND.

	Inland.	Export.
(8) N.W. Coast—		
Steams		24/- to 25/-
Household		40/- to 56/-
Coke		22/6 to 23/6
Northumberland—		
Best Steams		13/6 to 14/-
Second Steams		13/-
Steam Smalls		10/6
Unscreened		13/- to 13/6
Household		21/- to 27/-
Durham—		
Best Gas		16/-
Second		13/9 to 14/-
Household		21/- to 27/-
Foundry Coke		19/- to 26/-
Sheffield—	Inland.	
Best Hand-picked Branch	28/- to 30/6	—
Best Selected House Coal	22/6 to 23/-	—
Screened House Coal	19/- to 20/-	—
„ „ Nuts	16/- to 17/6	—
Yorkshire Hards	14/6 to 16/6	—
Derbyshire Hards	15/- to 17/-	—
Rough Slacks	9/- to 10/-	—
Nutty Slacks	7/- to 8/-	—
Smalls	3/- to 4/6	—
Blast-furnace Coke (Inland)	14/- to 14/6 at ovens	—
„ „ (Export) f.o.b.		18/6 to 19/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/6 to 20/-
Second Smokeless Large	19/- to 19/6
Best Dry Large	18/6 to 19/-
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/- to 18/3
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/6 to 17/9
Ordinary Eastern Valley Large	17/- to 17/6
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/- to 13/6
Washed Nuts	18/- to 21/-
No. 3 Rhondda Large	19/6 to 20/-
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/6
„ „ Through	15/- to 15/6
„ „ Nuts	13/- to 14/-
Foundry Coke (export)	35/- to 40/-
Furnace Coke (exp	27/6 to 30/-
Patent Fuel	23/6 to 24/6
Pitwood (ex ship)	32/9 to 33/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	34/- to 36/-
Seconds	28/- to 32/6
Red Vein	24/6 to 27/6
Machine-made Cobbles	37/6 to 42/6
Nuts	42/6 to 46/-
Beans	27/6 to 30/-
Peas	18/6 to 20/-
Breaker Duff	8/6 to 9/-
Rubbly Culm	8/9 to 9/3
Steam Coals:	
Large	18/6 to 19/6
Seconds	17/6 to 18/-
Smalls	10/6 to 12/-
Cargo Through	15/6 to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate 7/6 joists and 5/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Sales Comptoirs.

The belief that the autumn would bring about a seasonable demand for rolled steel has not been fulfilled, and while there is a little more buying, the situation has not improved to the extent of relieving the industry from the present severe depression. Makers, however, look to the future with more confidence in view of the stronger position of the Steel Cartel, which appeared at one moment on the point of collapsing through the failure of that organisation to maintain prices at a profitable level, but German firms are probably more interested than the French in preserving a system of restricted output which will prevent competition in their own market, although there is still some little anxiety in this country as to what will happen in the event of the German consumption falling below the production and producers being obliged to dispose of a surplus abroad. The Cartel is maintained chiefly as a means of bringing to a successful issue the negotiations for international sales organisations of rolled steel, which the Germans have always regarded as indispensable to the working of the Cartel, and all the members of that body agree that the situation can only be improved by allotting to each country a quota of manufactured iron and steel for export. There are difficulties in the way through the necessity of each country first of all arranging for an allotment amongst individual producers, for that is by no means an easy matter, and amongst the French rolling mills there is already some dissatisfaction over the curtailment of quantities supplied for export by certain firms.

Algerian Public Works.

The programme of public works which is being extended over a period of five years, and is expected to be completed in 1930, continues to be carried out methodically with an increasing yearly expenditure, and while during the present year the sum devoted to the works is 107,200,000 francs, it will amount, in 1928, to 150,470,000 francs. The most urgent need has been the carrying out of hydraulic works with a view of regulating the supply of water, mainly for irrigation purposes, and half a dozen barrages are now under construction for the creation of reservoirs. Preparations are being made for the construction of several others, and in course of time every source of water supply in Algeria will be preserved in that way. About one-third of the amount of credits is devoted to hydraulic undertakings. Drainage works are also being carried out on a large scale, and a great deal is being done in the way of harbour extensions and improvements. Large sums are being devoted to the harbours at Oran, Algiers, Arzew and Mostaganem. This activity in the development of Algeria is providing some employment to French engineers, and it will become still more important during the next few years. The Colonies are also contributing orders for railway and public works material, which are very acceptable to manufacturers, who find it difficult to tide over the present period of depression. Competition for the work is nevertheless very keen, and remarkably low estimates are often submitted.

Electrification.

Following upon the Eguzon hydro-electric power station, which was the first to be put into service for the electrification of the Paris-Orleans Railway, the Coindre power station was recently started, but it appears that the work on the other installations constituting the Upper Dordogne group, which are to complete the electrification beyond Vierzon, are being retarded for financial reasons. At the time of the currency depreciation there seemed to be no difficulty in carrying out an enterprise that would provide for a vast system of railway electrification, but since the stabilisation of the franc the conditions have changed, and the higher value of the national currency has narrowed down the advantages which were to have been derived from the electrical equipment of railways. There is consequently some hesitation in pushing forward with the scheme, and the construction of the Collette and Vernéjoux-Marèges barrages and power stations, both on the Dordogne, has had to be delayed until the financial situation becomes more favourable. The cost of the Eguzon and Coindre power stations has been increased enormously by the monetary appreciation. The Coindre power station is situated at the junction of the Grande Rhue and the Petite Rhue, and owing to the difference of volume of these two tributaries they are connected by a system of galleries. On the Grande Rhue the concrete barrage has a height of 48 m. above the foundation, while that of the Petite Rhue has a height of 35 m. The head of water to the power station is 120 m., and the three Francis turbines drive alternators each of 8600 kWa at 5000 volts. A Pelton wheel drives an alternator for the auxiliary services. Transformers raise the tension to 90,000 volts, and a line 15½ miles long carries the current to the central station at Marèges, where the pressure is raised to 220,000 volts for transmission to Paris and to the Paris-Orleans system.

Coal Production.

The output of coal at the French collieries during August was 4,379,010 tons, as against 4,275,702 tons in July, when the number of days worked was one less. There has been a reduction in the number of hands and a falling off in the daily production, particularly in the centre and the south, but in the Nord and the Pas de Calais the output is maintained. Fuel from the northern coalfield is now being carried to Channel and Atlantic ports under the arrangement made some time ago whereby specially low freights are offered for the consignment of coal which is expected to compete with British fuel, and the immediate result has been to arouse protests from the Loire coal merchants, who find that the companies in the Nord and Pas de Calais are depriving them of their trade with Bordeaux and elsewhere.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

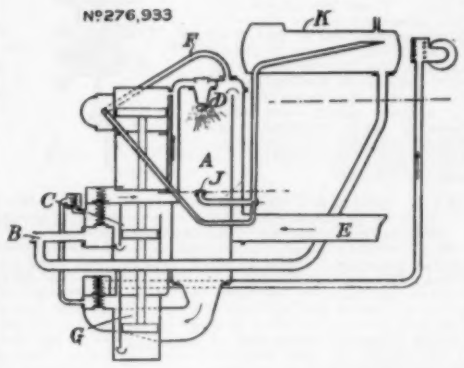
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

276,933. May 23rd, 1927.—Feed-water Heaters, Société Française des Pompes et Machines Worthington, 1, Rue des Italiens, Paris.

This feed-water heater is intended for service on locomotives or other engines which work intermittently, and the aim is to prevent the heater being flooded. The heater itself is shown at A. Into it the feed water from B is pumped by the pump C through the spray D. The exhaust from the main engine for

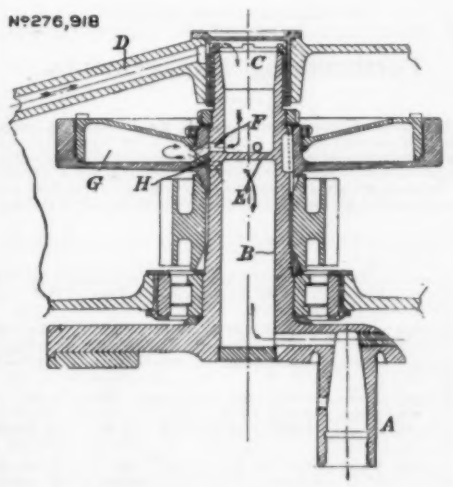


heating purposes arrives by the pipe E, while the exhaust from the pump is similarly used *vid* F. The combined condensate and feed is taken away by the pump G and fed to the boiler through the check valve. At the critical flooding level of the heater there is an ejector J, using part of the exhaust from the pumping engine, which delivers any surplus water to the tank K, in the tender, from which it gravitates back again to the general system.—*September 8th*, 1927.

INTERNAL COMBUSTION ENGINES.

276,918. July 22nd, 1926.—Lubrication of Aero-engines, D. R. Pobjoy, Chiltern-road, Wendover, Bucks.

The object of this invention is to provide the crank pin A of an aeroplane engine with lubricating oil as free as is possible from solid impurities. The crank shaft B is open at its free end C, into which the lubricating oil is introduced by the passage D. The oil passes down the hollow crank shaft, but is stopped by

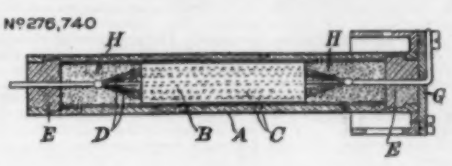


the diaphragm E. It escapes by the ports F into the hollow fly-wheel G in which any impurities are separated by centrifugal force. The oil then passes on by the ports H to the crank pin. Any impurities which may accumulate within the periphery of the fly-wheel may be easily cleaned out by dismantling the two parts of the fly-wheel, which are screwed together.—*September 8th*, 1927.

SWITCHGEAR.

276,740. June 2nd, 1926.—Improvements in or relating to Electric Fuses, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne; Bruce Hamer Leeson, of "Waverley," Tynemouth, Northumberland; and Richard Harry Brierley, of 4, Victoria-square, Jesmond, Newcastle-upon-Tyne.

The object of this invention is to construct a fuse of the cartridge type, having a low ratio between its minimum fusing current and its normal carrying current, and in which the effect of the explosive action on short circuit is minimised. Advantage is taken of the well-known fact that the ratio between the minimum fusing current and the normal carrying current is decreased by the employment of two or more fusible wires in parallel. The casing A is composed of fibre or other strong material, lined with asbestos. In the centre there is a core B, composed of cement or porcelain with passages through which the fusible wires D pass. The conductors to which these wires are connected pass through plugs, and at the ends of the fuse there are blocks G, only one of which, however, is shown. The spaces between the plugs E and the ends of the core B may be filled as at H with marble dust, which serves to quench the arc or absorb any generated gases. Some of the fusible elements may be made of copper, some of tin, or some may be of silver, and

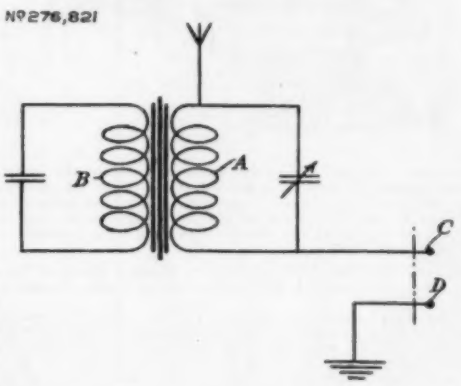


others of a metal having a relatively high specific resistance. The fusible elements may therefore be made to fuse in a definite sequence, and this is found to result in the production of a fuse that behaves in a more definite manner under short-circuit conditions, than a fuse of the ordinary type.—*September 2nd*, 1927.

TELEGRAPHS AND TELEPHONES.

276,821. August 21st, 1926.—Improvements in Anti-Static Arrangements in Wireless Receiving Apparatus, Arthur Elliot Beattie, of Manzanillo, Cuba, West Indian Islands.

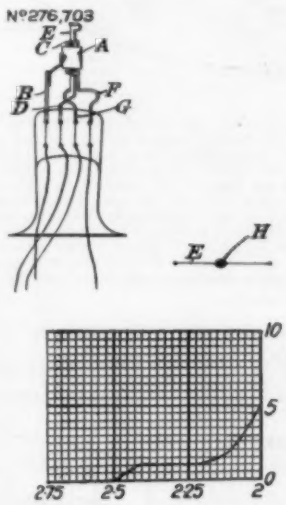
Many endeavours have been made to devise anti-static apparatus for wireless receivers, and, according to this invention, an iron cored transformer with a closed secondary winding resonant to low audio-frequencies with a capacity connected in parallel to pass radio-frequencies is connected in the aerial circuit of a wireless receiver, as shown. A is the primary winding of



the audio-frequency transformer, and B the secondary winding. The latter is provided with a fixed and the former with a variable condenser. The transformer may have from 160 to 200 turns on the primary winding, and from 50,000 to 80,000 turns on the secondary winding, wound on a bobbin 1in. in diameter and 2½in. long, and having a closed core. A suitable value for the variable condenser is 0·0003 microfarads, and that for the fixed condenser 0·002 microfarads. C and D are, of course, the aerial and earth terminals respectively.—*September 8th*, 1927.

276,703. April 28th, 1926.—Improvements in or relating to Thermionic Valves, The Edison Swan Electric Company, Ltd., of 123–125, Queen Victoria-street, London, E.C. 4; Leonard Henry Soundy, of 8, Chester-gardens, Argyle-road, Ealing, W. 13; and Thomas Willis Price, of 14, Westfields-road, Acton, W. 3.

According to this invention, in a thermionic valve in which the cathode is heated by the flow of electric current, the area of the emitting surface of the cathode is such that the potential drop across the emitting surface is less than one-tenth of a volt or is less than one-five-hundredth of the potential drop between the emitting surface and the anode. The cylindrical or flattened cylindrical anode A is carried upon a support B, and within the anode is a wire grid C of helical or flattened helical form carried



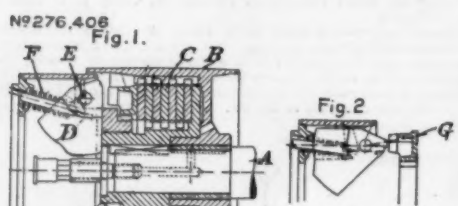
upon the support D. A filament E is mounted co-axial with the anode upon supports F and G. The supports are all secured to the pinch of the valve and act as lead-in wires for their respective electrodes. The filament E is of platinum and is provided with a spot of relatively highly emissive material H. This emissive material covers only a small proportion of the whole length of the filament. In one case the filament was 15 mm. in length, and the emitting surface was about 0·5 mm. in length. When a cathode of this type is heated by the passage of an electric current the emission of electrons from the uncoated portion of the filament is very small or negligible, compared with that from the coated portion at the working temperature. In the example given above, the drop of potential across the emissive portion of the cathode will only be one-

thirtieth of the total potential drop across the filament, and if the applied potential difference is 1 volt, the voltage drop across the emissive portion will only be one-thirtieth of a volt. A valve constructed according to the invention is particularly suitable for use as an anode bend rectifier of modulated high-frequency waves. The curve shows on an enlarged scale the lower bend of the anode current grid voltage characteristic of a valve according to the invention. The ordinates give anode current in micro-amperes and the abscisse give negative grid voltage. It will be observed that the rate of change of slope to the left of 2·2 volts is very small, whilst that to the right of this point is very great. The valve will therefore act as a very efficient detector at this point. It will also be observed that by taking the normal grid voltage slightly on the negative side of this point, the valve can be made very selective, since, for example, a grid swing of 1 volt can be made to give practically no change of anode current, whilst a larger swing will give a relatively large change.—*August 29th*, 1927.

TRANSMISSION OF POWER.

276,406. July 27th, 1926.—Friction Clutches, H. H. Benn, Templewood, Farnham Common, Bucks.

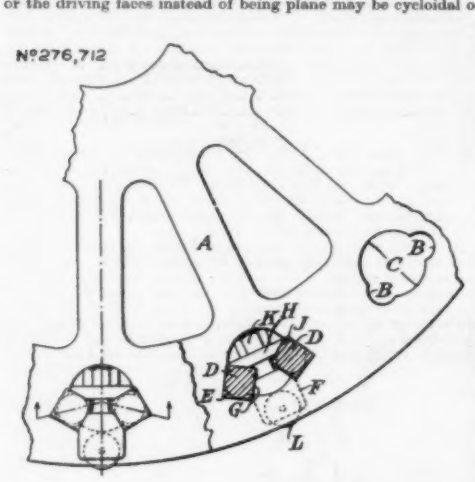
This clutch is of the centrifugal type used to enable motors to start up and gain speed before the load comes on. A is the motor spindle, and B the belt pulley. The pulley runs idly on the shaft, but may be driven by the friction discs C. The



necessary pressure between the discs is provided by the centrifugal weights D, which are pivoted at E. When the weights fly out, under the influence of centrifugal force, and against the springs F, the nose of the weight presses against the ring G, as shown in Fig. 2, and closes the friction discs together.—*September 1st*, 1927.

276,712. May 3rd, 1926.—Sprocket Wheels, Roadless Traction, Ltd., and E. L. Firth, Gunnersbury House, Hounslow, Middlesex.

The object aimed at here is to provide renewable wearing surfaces for a sprocket working in conjunction with a toothed chain. Referring to the drawings, the sprocket wheel is formed from two plates A, having semi-circular holes B cut in pairs around their periphery, the metal between the holes being cut away as at C to allow for the insertion of bar elements D forming the teeth or driving surfaces. The elements D are shown as being of square section, but may be of any polygonal section, or the driving faces instead of being plane may be cycloidal or

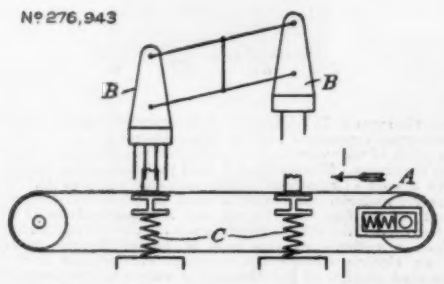


of any other suitable curved surface. They are formed with grooves E with circular bases to conform to the circular holes B, with which they engage, being held in position by bolts F. The heads of the bolts F are provided with surfaces G adapted to lie against the faces of the elements D, which are secured between the surfaces G and similarly bevelled surfaces J on similar plates H by means of nuts K. Rubber or other resilient blocks L are placed in sockets in the heads of the bolts F and serve to silence the track. When one driving surface has become worn, a fresh one may be brought into play by merely slackening off the nuts K until the elements are freely rotatable.—*September 5th*, 1927.

MINING MACHINERY.

276,943. July 14th, 1927.—Coal Breakers, B. Norton, Sandford Hall, Claverley, near Wolverhampton.

In this machine the coal is broken up as it passes along a con-

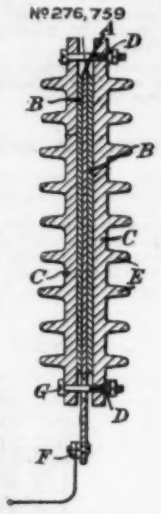


veyor A by the action of reciprocating picks B B. In order to prevent the wreckage of the machine in the event of some hard substance passing under the picks, the belt of the conveyor is supported by anvils, carried on springs C C, which will yield in case of emergency.—*September 8th*, 1927.

MISCELLANEOUS.

276,759. June 9th, 1926.—Improvements in or relating to Alternating-current Rectifying Devices, Samuel Ruben, of 70, East 93rd-street, New York City.

One form of rectifier described in this specification is shown in the accompanying drawing. It comprises a central electrode A of copper, having both extended surfaces in contact with plates B of cupric sulphide (CuS) which in turn have their outer or remote faces in contact with a pair of aluminium electrodes C, the whole being clamped together by clamping bolts, as shown, and maintained under pressure by spring washers D. The inner or contacting surfaces of the aluminium electrodes C are provided with a film of aluminium sulphide, while the other faces are provided with flanges E to facilitate the radiation of heat. Where the central electrode passes out beyond the lower clamping bolt, it is perforated with an opening adapted to permit a bolt to pass there-through without touching. A binding post F is mounted on the central electrode for making circuit connections therewith, while connection may be made with the aluminium electrodes through the lower bolt G.—*September 8th*, 1927.



276,874. January 3rd, 1927.—Non-magnetic Alloy of High Electrical Resistance, Yoshiatsu Kamishima, of No. 16, Kasuga Cho, Dairen, South Manchuria, China.

This invention relates to non-magnetic alloys of high electrical resistance consisting of iron to which chromium and nickel are added. The object of the invention is to obtain such an alloy, in which blow holes are not produced while it is being cast into ingots, and which does not oxidise or scale when subject to a high temperature. An alloy is made consisting of 9—12 per cent. of nickel, 15—20 per cent. of chromium, 0·3—2 per cent. of manganese, iron and impurities including carbon forming the remainder. The high resistance of the alloy is obtained by making the carbon content as low as possible, and by having a large proportion of nickel and chromium. The effect of the manganese upon the product is very great, for example, in Stanton's test, the index number for the product containing about 1 per cent. of manganese lies between 2400 and 3000 as compared with about 600 for a product containing no manganese. Furthermore, the manganese greatly increases the uniformity after casting and the tensile strength of the alloy. An alloy made according to the invention is said to be well adapted to withstand alternately repeated stresses, such as are set up in a crank shaft in an aeroplane engine, &c. It is absolutely non-magnetic, it has an electrical resistance 60 times as great as that of copper at 0 deg. Cent., and twice as great as that of nickel-chromium alloys hitherto employed. Further, it has a tensile strength of 55 tons, a maximum elongation of 55 per cent. Its hardness according to Brinell's scale of hardness is 200 deg., and it cannot be oxidised in air even if heated at 1600 deg. Cent. It is also said to be far more ductile than other nickel chromium alloys and more satisfactory to cast, and, moreover, being cheap, it is suitable for use in the construction of machine shafts, &c. The precise method of making the alloy is described.—*September 8th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Chemical Engineering Group.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "A Recent Development of Spray Drying," by Mr. J. A. Reavell. 8 p.m.

Institute of Metals: Sheffield Local Section.—Applied Science Department of the University, Sheffield. Chairman's address, "Science and Industry," by Mr. J. H. G. Monypenny. 7.30 p.m.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Electric Power Cables and Recent Developments," by Mr. C. M. Read. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Problems Created by the Rapid Development of the Motor Car Industry," by Mr. F. A. Simpson. 7.30 p.m.

Keighley Association of Engineers.—Room 14, Temperance Institute, Keighley. Lecture, "The Economy of Prime Movers," by Professor W. T. David. 7.30 p.m.

Manchester Association of Engineers.—The Engineers' Club, Albert-square, Manchester. Opening address by the President, Mr. S. H. Heywood, followed by a smoking concert. 7.15 p.m.

SATURDAY, OCTOBER 15TH.

North of England Institute of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Presidential address, by Mr. Mark Ford. Papers, "The Dry Cleaning of Coal," by Mr. J. S. Carson, and "Notes on an Inrush of Water at the Montagu Colliery, Scotswood, Northumberland, on March 30th, 1925," by Mr. H. T. Foster. 2.30 p.m.

MONDAY, OCTOBER 17TH.

Bradford Engineering Society.—Technical College, Bradford. Lecture, "A Word in Favour of the Independent Power Plant," by Mr. W. C. Mountain. 7.30 p.m.

Railway Club.—25, Tothill-street, Westminster, London, S.W. 1. Paper, "Outdoor Interlocking Apparatus," by Mr. R. G. de Bray. 7.30 p.m.

TUESDAY, OCTOBER 18TH.

Institution of Automobile Engineers.—Broadgate Café, Coventry. Coventry Graduates' meeting. 7.15 p.m.

Institution of Automobile Engineers: Wolverhampton Centre.—Engineering and Scientific Club, Wolverhampton. Presidential address, "The Influence of the Automobile User upon the Automobile Engineer," by Major E. G. Beaumont. 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. Papers: "The Industrial Engineer," by Mr. A. J. T. Taylor; "British Engineering Export Problems," by Mr. W. S. Murphy. 7.30 p.m.

TUESDAY AND WEDNESDAY, OCTOBER 18TH AND 19TH.

Society of Glass Technology.—Meetings in Sheffield.

WEDNESDAY, OCTOBER 19TH.

Chemical Engineering Group.—Ca'doro Restaurant, Union-street, Glasgow. Paper, "The Desiccation (De Vecchis) Process of Beet Sugar Manufacture," by Dr. C. Scott Garrett and Mr. G. W. Riley. 7 p.m.

Institution of Automobile Engineers.—Chamber of Commerce, Birmingham. Paper, "Skids," by Mr. E. Robinson, 7.30 p.m.

Institution of Civil Engineers: Manchester and District Association.—Literary and Philosophical Society's Rooms, 36, George-street, Manchester. Address by the Chairman, Mr. Daniel Adamson. 6.45 p.m.

Newcomen Society.—Demonstration Room, Ground Floor, Science Museum, South Kensington, London, S.W. 7. Paper, "The Development of the Organ," by Mr. E. W. Anderson. 5.30 p.m.

THURSDAY, OCTOBER 20TH.

Institute of Metals: Birmingham Local Section.—The Engineers' Club, Waterloo-street, Birmingham. Paper, "Isotopes," by Dr. G. W. Aston. 7 p.m.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Presidential address, by Mr. Archibald Page. 6 p.m.

Institution of Mechanical Engineers: North-Western Branch.—The Engineers' Club, Manchester. Paper, "The Mechanical Testing of Materials," by Mr. R. E. Bailey. 7.15 p.m.

FRIDAY, OCTOBER 21ST.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Presidential address, by Sir Henry Fowler, K.B.E. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecture, "Piling in General with Special Reference to the Vibro Concrete Piling System," by Mr. M. McCarthy. 7.30 p.m.

West of Scotland Iron and Steel Institute.—Room 24, Royal Technical College, George-street, Glasgow. Presidential address by Mr. John Craig. 7 p.m.

SATURDAY, OCTOBER 22ND.

Institution of Municipal and County Engineers.—The Mansion House, Doncaster. Yorkshire District meeting. 11 a.m.

MONDAY, OCTOBER 24TH.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Presidential address, "The Influence of the Automobile User upon the Automobile Engineer," by Major E. G. Beaumont. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster, London, S.W. 1. Graduates' Section meeting. "The Liquefaction of Air," by Mr. J. Rogers. 6.30 p.m.

WEDNESDAY, OCTOBER 26TH.

Institution of Automobile Engineers: North of England Centre.—The Engineers' Club, Albert-square, Manchester. Presidential address, "The Influence of the Automobile User upon the Automobile Engineer," by Major E. G. Beaumont. 7 p.m.

FRIDAY, OCTOBER 28TH.

Institution of Chemical Engineers.—Institution of Civil Engineers, Great George-street, Westminster, London, S.W. 1. Lecture, "Crystallisation," by Sir William Bragg, F.R.S. 6.30 p.m.

Institution of Locomotive Engineers: Manchester Centre.—College of Technology, Sackville-street, Manchester. Paper, "Locomotive Performance and its Influence on Modern Practice," by Mr. E. C. Poultney. 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Whitbrows Ltd., of 85, Gracechurch-street, London, E.C. 3, asks us to announce that it has been appointed selling agent for the Oidas Metals Company, Ltd., Granville Smelting Works, Brettenham-road, Edmonton, N.

Sir Alfred F. Yarrow asks us to announce that, on account of his advancing years—he is nearly eighty-six years of age—he has determined to resign his position of President of Yarrow and Co., Ltd., of Scotstoun, Glasgow.

Vickers Ltd. asks us to announce that Mr. Alfred Cartwright has resigned his seat on its board, and that at a meeting of the Board held on the 6th instant General Sir Noel Birch, K.C.B., K.C.M.G., and Mr. G. G. Sim, C.S.I., C.I.E., the secretary of the company, were appointed directors.

CONTRACTS.

Glenfield and Kennedy, Ltd., Kilmarnock, inform us that the recent tender of their branch in Bombay for the supply of sluice gates for the Panjnad Barrage on the river Sutlej has been accepted by the Government of India. The work comprises thirty-three gates, 60ft. span by 13ft. 6in. deep, of the free roller type, complete with all details. The order was secured in the face of keen international competition.

The English Electric Company, Ltd., has recently installed a third 12,500-kW turbo-alternator set at the Ribble power station of the Preston Corporation. The installation during the course of next year of a duplicate of the set mentioned above will bring the capacity of the station up to 50,000 kW. The same firm has recently received an order for a steam turbine-driven turbo-blower from Newton Chambers, Ltd., of Sheffield. The blower is to be capable of delivering varying quantities of air, according to the requirements of the furnace, up to a maximum of 30,000 cubic feet per minute. It will be coupled to an English Electric impulse turbine of 2300 B.H.P. output.